RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

Vol. 69 NOVEMBER 1957 No. 5

The Role of Barium Contrast Studies in the Diagnosis of Retroperitoneal Tumors[1]

ROBERT M. LOWMAN, M.D., and LEONARD DAVIS, M.D.

THE RADIOLOGIST is walking along an ever narrowing tightrope in the investigation of a patient with a poorly defined symptom complex. It is easy to stumble between the dangers of the well publicized limits of total-body irradiation and the risk of missing an elusive lesion because of inadequate examination. For this reason roentgenographic procedures should be constantly reappraised to make certain that the simplest possible technics offering the greatest possible rewards are used.

The study of retroperitoneal tumors emphasizes this problem. The inaccessibility of the retroperitoneal space masks early symptoms and makes physical diagnosis uncertain. This has led to the development of complex and difficult, though specific, roentgenographic procedures, permitting more accurate evaluation. These complex procedures have in turn increased the value of the comparatively simpler and safer method of barium studies of the digestive tract in the search for retroperitoneal masses. The distortions and the displacements of gastrointestinal structures noted during such routine examinations have taken on increased significance in view of the knowledge gained by investigations utilizing pneumography and aortography. Barium contrast studies, therefore, have become an accurate method, serving multiple purposes while keeping their chief advantage of simplicity.

It is the purpose of this review to assay the role of barium contrast examination in the diagnosis of retroperitoneal tumors. Such a study is the pivot for an investigation of the patient with an abdominal mass or with vague complaints referred to the abdomen. Its primary function is to exclude intrinsic lesions of the gastrointestinal tract. It is a grossly sensitive indicator in an evaluation of abdominal masses already known to be present. At times, it serves to detect and delineate unsuspected masses. In every instance, it is useful in directing the need and nature of subsequent roentgenographic studies.

The limitations of the barium contrast study should be noted at the onset of this evaluation.

1. Such studies are nonspecific, since displacement of a barium- or an air-filled hollow organ may be produced by any mass, whether neoplastic or inflammatory in origin.
2. The principal function of these studies is to provide a precise

[1] From the Department of Radiology, The Memorial Unit, Grace-New Haven Community Hospital, Yale University Medical Center, New Haven, Conn. Presented as part of a Symposium on Contrast Media in the Diagnosis of Retroperitoneal Abnormalities, at the Forty-Second Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2–7, 1956.

topographic analysis of the masses producing displacement of adjacent structures. Often, however, the desired goal is merely approximated.

3. The critical size of the mass determines the efficiency of the study. The mass must be large enough to produce indentation or displacement of the bowel loops. Paradoxically, very large masses that fill the abdomen and displace the bowel loops and viscera to a marked degree often defy evaluation by barium contrast methods.
4. The barium contrast studies obviously fail in the presence of masses which follow the contour of the retroperitoneal space, with no anterior projection (Fig. 1).

Perplexing problems are often encountered because of the deep-seated location of tumors in the retroperitoneal area and their relative inaccessibility to routine diagnostic procedures. For this reason special emphasis must be placed upon roentgenography in the evaluation of tumors in this area. The superiority of roentgen diagnostic efforts is more than adequately shown by a review of retroperitoneal tumors seen before 1930. In that era, adequate studies were almost completely lacking in most of the cases reported (20). A comparison of these cases with those observed between 1942 and 1956 indicates the greater reliance on roentgen studies, reflected in a striking increase in correct preoperative diagnoses.

TERMINOLOGY

Actually retroperitoneal tumors have little in common except for their position. The term retroperitoneal is applicable to any mass which has involved the potential space lying behind the peritoneal cavity, converting it into an actual space either (*a*) by arising in the area intrinsically, (*b*) by metastatic involvement, or (*c*) by invasion from contiguous growths. Some investigators have limited the designation retroperitoneal to a restricted group of tumors originating within the potential retroperitoneal space. Detailed classifications by Ackerman (1) Stout (14), Engel (11), Pack (22) and others have been developed to serve the needs of surgeons, pathologists, and urologists. These classifications, however, often fail to assist the radiologist, whose primary concern is with the nonspecific visceral displacement demonstrated on the roentgenogram (Figs. 2 and 3). For him, it is more pertinent to consider retroperitoneal tumors as a broadly defined concept encompassing all masses within the retroperitoneal space. Such masses fall into four categories: (*a*) tumors arising as primary unattached masses, perhaps originating from the embryonic urogenital tissues (15); (*b*) tumors developing in organs normally present in the retroperitoneal space; (*c*) primary or metastatic tumors involving the retroperitoneal lymph nodes as a manifestation of a systemic process; and (*d*) tumors arising intraperitoneally but invading the extraperitoneal space by extension.

It may be appropriate for the radiologist to consider retroperitoneal tumors in much the same manner in which he regards abdominal masses. From this point of view, retroperitoneal tumors are the counterpart of intra-abdominal masses, and, although they may simulate one another, they may be distinguished by much the same approach. Barium contrast studies serve a common purpose: the assessment of intraperitoneal as well as retroperitoneal masses.

To summarize: (*a*) The studies are utilized primarily to exclude the presence of intrinsic lesions within the gastrointestinal tract. (*b*) They provide an appreciation of the presence of unsuspected masses. (*c*) They delineate abdominal masses known to be present. (*d*) They are the pivotal point for outlining subsequent studies.

ANATOMY

For the purpose of graphic simplification of the anatomy, the potential retroperitoneal space may be looked upon as

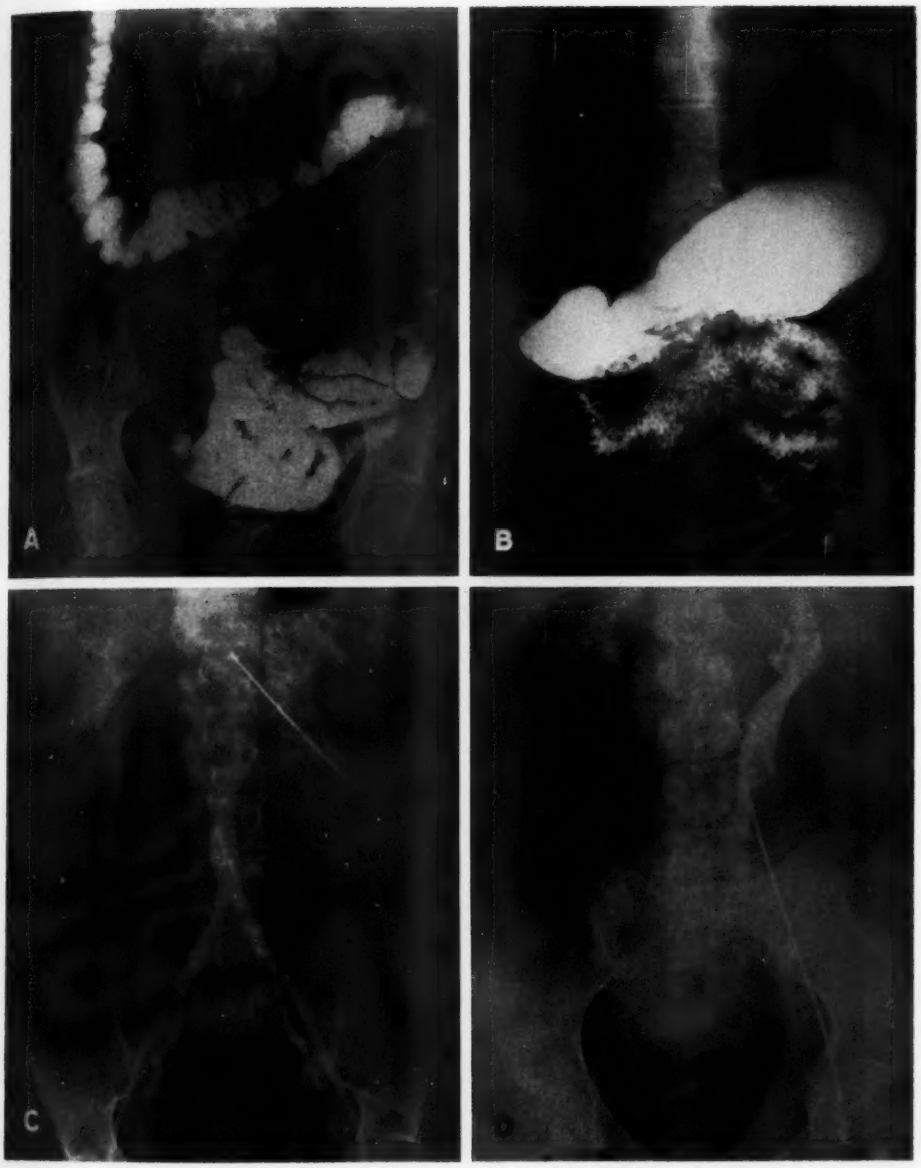
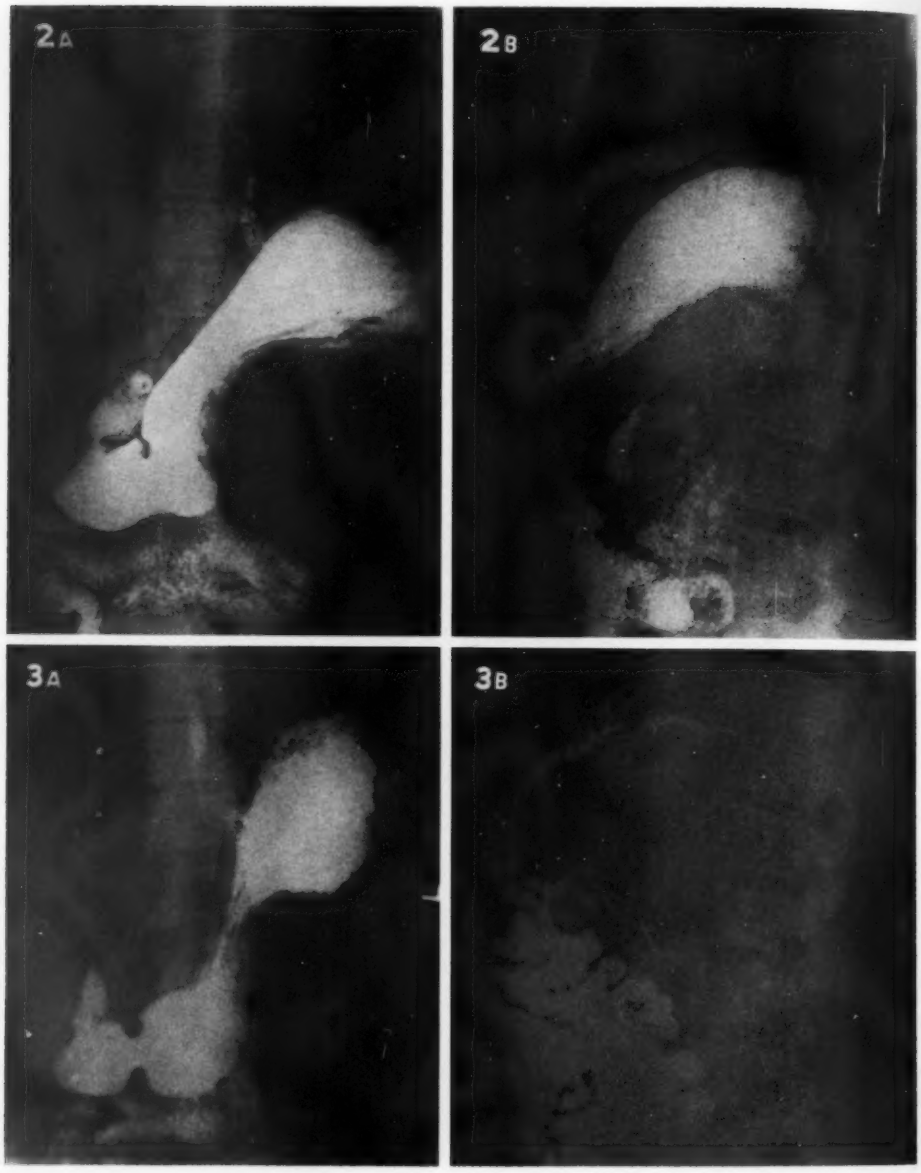


Fig. 1. Group of films demonstrating limitations of the barium contrast studies and the necessity for complete and thorough investigations to delineate a retroperitoneal mass. The case is one of retroperitoneal fibromyxoma in a white female fifty-five years of age, with a palpable epigastric mass.

A. and B. Barium studies. Despite absence of indentation phenomena and visceral displacement, these studies acted as a pivotal point for the subsequent examinations.

C. Aortogram showing absence of abdominal vascular pattern and of displacement of the vessels but indicating that the mass was not of renal origin.

D. Retrograde venogram revealing displacement of the vena cava and an epigastric mass. This latter finding was confirmed at operation, which demonstrated also involvement of the wall of the vena cava.



Figs. 2 and 3. Further examples of the limitations of the barium contrast examination. These studies illustrate the nonspecificity of the displacement and indentation phenomena thus demonstrated. Fig. 2 shows mesial and superior displacement of the body of the barium-filled stomach, while the duodenojejunal flexure is displaced anteriorly and downward. A large pancreatic cyst was demonstrated at surgery. The similar roentgen findings in Fig. 3 were produced by a retroperitoneal lymphosarcoma.

having the shape of a cradle. This cradle holds within its embrace the intra-abdominal contents, some of which are partially fixed. The relationship of the bowel loops to the retroperitoneal cradle, and the pressure patterns formed by masses within it are the basis for the gastrointestinal examination (Fig. 4).

Tumors originating in the space of the cradle may arise from the embryonic urogenital ridge, adipose tissues, areolar connective tissues, fascia, lymph nodes, lymphatics or sympathetic nervous system. As these masses develop, they may lift any of the abdominal viscera from the posterior wall and may extend into the mesentery of the large and small intestine, producing sufficient distortion to be evident on contrast studies (15).

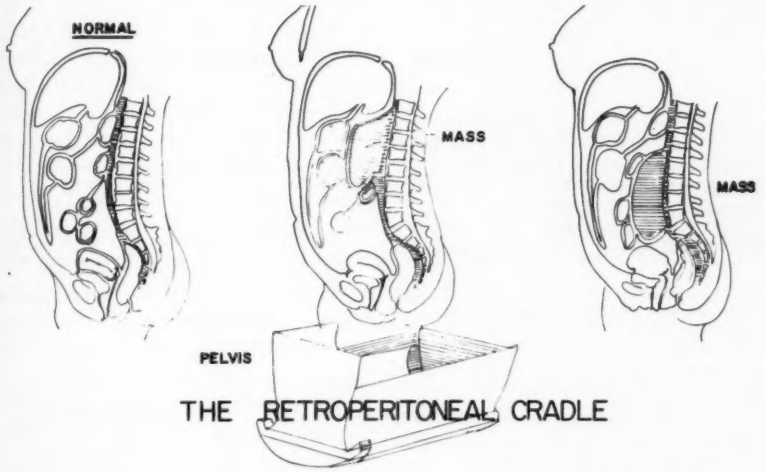


Fig. 4. Schematic outline of the retroperitoneal space, showing patterns of displacement. The extent of the retroperitoneal space can best be appreciated in the lateral view, which also illustrates most clearly the concept of the retroperitoneal cradle. The abdominal contents resting in the cradle will show anterior displacement by masses developing in the potential retroperitoneal space. The anterior displacement of fixed landmarks will indicate the posterior position of the mass.

It should be emphasized that the retroperitoneal space as defined for radiologic purposes contains the retroperitoneal viscera, consisting of the kidneys, the adrenals, parts of the pancreas, and segments of the gastrointestinal tract. The presence of the aorta and of the inferior vena cava should not be overlooked. Any of these structures may give rise to masses which simulate what other investigators have defined as primary retroperitoneal tumors. These tumors may be malignant or benign, simple or multiple, solid or cystic, and may occur in either sex or at any age (8). They display a diversity of origin and a variation in histologic type that make them the trap door of diagnostic acumen.

METHOD OF STUDY

The basis for an orderly approach to the roentgen diagnosis of abdominal masses and retroperitoneal tumors is a careful topographic analysis (6). The diagnostic accuracy of the roentgen method depends upon (*a*) a statistical appreciation of the incidence of different tumors in the regions involved, and (*b*) the ability to localize masses in the suspected areas. Two modes of investigation—direct and indirect—are used. Plain films of the abdomen, barium contrast studies of the gastrointestinal tract, and pyelography are the conventional radiographic procedures representing the indirect methods. Because of their relative simplicity and accuracy, they precede the use of direct means of examination, such as retroperitoneal pneumography, aortography, venography, and nephrotomography.

Indications for the use of the more precise, direct technics, singly or in combination, are derived from the indirect

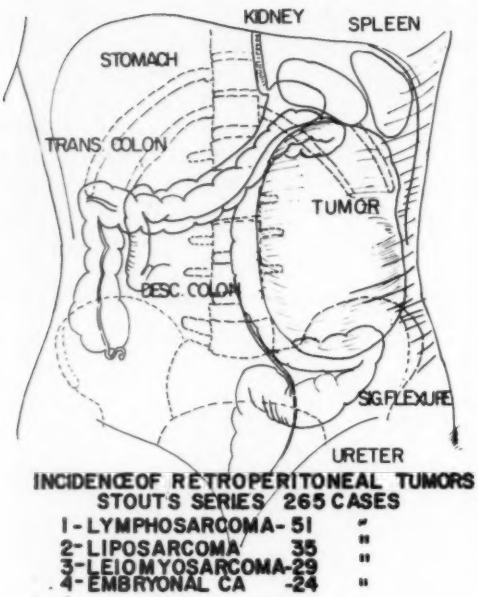


Fig. 5. Schematic representation of the radiologist's concept of the classical retroperitoneal mass. The tumor is made manifest by the displacement of adjacent viscera in the anteroposterior studies. Thus, the left-sided mass may produce downward displacement of the splenic flexure and mesial displacement of the descending colon. Indentation of the greater curvature of the stomch and distortion of the duodenojejunal flexure are to be sought for in such a case. The renal outline may reveal upward displacement.

The incidence of the four most common malignant retroperitoneal tumors as noted from Stout's series (28) is recorded.

examinations. The purpose of the latter is, essentially, to distinguish the mass from the principal organs in the abdomen and to define it in terms of displacement and pressure phenomena. The gastrointestinal tract, because it extends into almost every region of the abdomen, is likely to be affected by an expanding growth in either the intraperitoneal or retroperitoneal area. Barium contrast studies are thus the common denominator in the evaluation of all abdominal masses (Fig. 5).

A balance of four factors is used in the initial study of an abdominal mass: (*a*) the regional anatomy, which must be analyzed for evaluation of displacement and pressure distortion; (*b*) general roentgen characteristics of the mass, such as its shape, size, consistency, and the character of its border; (*c*) specific roentgen characteristics; (*d*) the statistical probability of occurrence of a particular tumor in the area under consideration.

In order to differentiate intraperitoneal from retroperitoneal masses, precise knowledge of the peritoneal reflections is demanded. The development of a detailed topographic classification, however, is not necessary if several simple, but pertinent, questions are kept in mind:

1. Is the mass in the upper abdomen related to the liver, spleen, pancreas, or adjoining bowel?
2. Is the mass in the lower abdomen related to the uterus or ovaries?
3. Is the mass of renal or adrenal origin?

In the planned investigation, a plain film of the abdomen is the initial step. This may reveal (*a*) alteration in size, shape, and position of the renal shadow or obliteration of the psoas margin; (*b*) distortion or displacement of the more opaque homogeneous shadow of an extraluminal mass of adjacent hollow viscera retaining air; (*c*) areas of radiolucency such as characterize a significant percentage of lipomatous tumors; (*d*) localized areas of calcification or opacification, which may identify tumors of neurogenic or teratomatous origin; (*e*) deformities of the vertebral column either resulting from pressure, such as those produced by a chordoma, or associated with congenital abnormalities, as an anterior meningocele in the lumbar or sacral area.

The object of the gastrointestinal examination, extending from the esophagus to the rectum, is the demonstration of points of reference to which attention can be directed (4, 5, 23, 29). For this purpose the abdominal cavity may be regarded as a series of compartments, each containing a group of organs whose displacement may outline the mass which is responsible for the deformity (19). Of particular importance is the fact that each compartment possesses fixed points which may

reflect the influence of an adjacent mass. These are: (*a*) the attachment of the stomach; (*b*) the contour and relationships of the duodenal bulb, the descending loop of the duodenum, and the duodenojejunal flexure; (*c*) the flexures of the large bowel; (*d*) the position of the ascending and descending colon with reference to the posterior abdominal wall; and (*e*) the relationship of the rectum to the sacral margins. The anterior displacement of these fixed points on lateral views will designate the retroperitoneal position of an abdominal mass. Lateral and mesial, superior and inferior displacement offer further definition of the mass.

The actual technic of the examination of the stomach has been emphasized by Engel and Lysholm (10), Scheinmel and Mednick (26), and Meschan *et al.* (17) in their studies of the retrogastric space by gastric pneumography and barium contrast. Measurements were provided by these investigators for the detection of space-occupying retroperitoneal masses in the upper abdomen by an evaluation of the

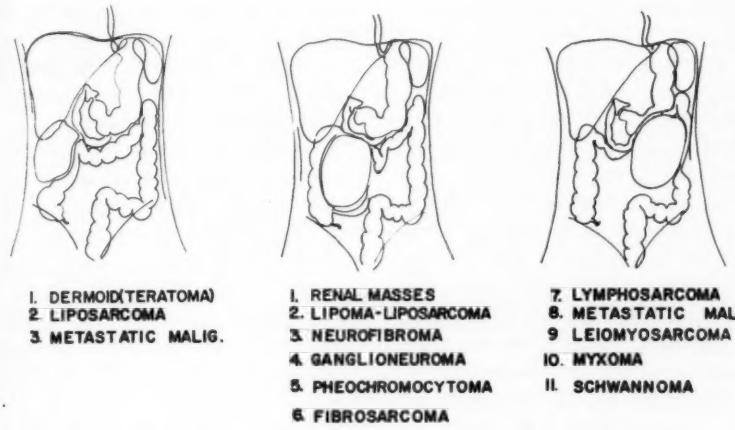


Fig. 6. Patterns of displacement of the visceral contents of the abdominal cavity by tumors in different regions of the abdomen.

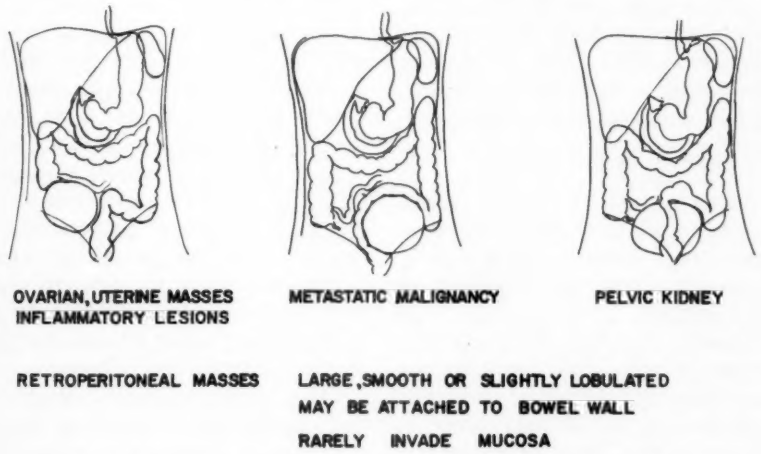


Fig. 7. Patterns of regional distortion exhibited by pelvic masses.

mobility of the stomach. In addition to the routine gastrointestinal tract examination, a modified study of the small bowel may supply valuable information. Survey studies will aid in evaluating the appearance of the small intestine and in determining the presence of changes in the mucosal pattern, bowel contours and wall. Specific studies of anatomic variations of the fixed points of the colon and their displacement by tumors are not available. The use of barium contrast studies to demonstrate such displacement will be reviewed in the following sections.

Pyelography, as the last of the indirect examinations, is designed to visualize the displacement and distortion of the urinary tract by contiguous masses (13, 25). Establishment of the renal or adrenal origin of a particular mass, however, may demand greater relative precision than is offered by the methods of the indirect examinations. It is at this point that the complex direct studies are warranted. Pneumography, aortography, and nephrography are the big guns in the armamentarium of the radiologist in his attack on this problem (12). The premature use of these direct technics depreciates their value and enhances their danger.

MASSES IN THE UPPER ABDOMEN

The patterns formed by masses in the upper abdomen and their retroperitoneal counterparts are outlined schematically in Figures 6 and 7 and are described in the following sections.

Retroperitoneal masses of the right upper quadrant must be distinguished from enlargement of the liver and gallbladder. A mass or masses may occur in either or both of the lobes of the liver, usually producing a roentgen shadow inseparable from the liver and situated anteriorly in the lateral view. The gastrointestinal tract structures are pushed away from the predominant site of enlargement. While some liver masses may cause anterior displacement of the stomach, there is no anterior displacement of the duodenojejunal junction, of the hepatic flexure, or of the ascending colon. The latter findings are important in differentiating a retroperitoneal from an intrahepatic mass. Occasionally, an embryonal carcinoma or hepatoma may be outlined or identified by calcifications. The importance of the barium study is reflected in the search for the syndrome of primary hepatic cancer emphasized by Schatzki (24), namely cirrhosis, esophageal varices, a liver mass, and positive evidence of carcinomatous metastases.

Roentgen demonstration of hepatic enlargement must be evaluated and correlated with other findings. The liver may be enlarged in a variety of conditions, as cirrhosis, hepatitis, abscess, metastatic neoplasm, congestion associated with cardiac failure, hepatic fatty infiltration, reticuloses, carbohydrate storage disease, parasitic infestation, and congestive splenomegaly. Multiple small calcifications resembling phleboliths, located in the right upper and midquadrants in association with a known hemangioma elsewhere, may indicate hepatic hemangioma. A choledochal cyst in a jaundiced patient may present as a retroperitoneal mass producing a characteristic impression on the posterolateral aspect of the second portion of the duodenum.

Retroperitoneal masses of the left upper quadrant produce displacement patterns simulating splenic enlargement. These masses indent the greater curvature aspect of the stomach or depress the splenic flexure of the colon. They may be identified by lateral views demonstrating anterior displacement of the descending colon and of the duodenojejunal flexure. Rarely, the greatly enlarged spleen may displace the kidney, producing torsion and renal dystopia (13, 25).

Masses arising in the areas of "overlap" in the region of the tail of the pancreas, the adjacent margins of the spleen, and the underlying retroperitoneal sites are singularly difficult to evaluate. At all times, some of the conditions in which splenic enlargement may occur must be surveyed. These enlargements may appear

in hemolytic anemias, traumatic rupture, acute and chronic bacteremias, syphilis, tuberculosis, bacterial endocarditis, reticuloendothelioses, leukemias, rheumatoid arthritis, and amyloid disease. Rarely tumors and cysts may also involve the spleen (Fig. 8).

Intraperitoneal masses seldom produce renal displacement unless they have become very large, but many extra-alimentary masses of intraperitoneal origin may displace or indent the contiguous bowel loops. Mesenteric masses and omental cysts derived from lymphatic channels found in the mesenteric attachments of the large and small intestine frequently cause bowel displacements. Rarely, multiple masses of this type may occur. Identifying calcifications in these tumors are infrequently observed (16).

Alimentary duplications, enterogenous cysts, and mesenteric masses are usually contiguous, in part, with the bowel wall. This relationship may lead to partial intestinal obstruction or produce interference with the common blood supply, resulting in necrosis and hemorrhage. Bersack and his co-workers (3) have summarized the roentgen appearance of masses involving the wall of the small intestine and adjacent mesentery. Such masses may produce elongation and compression of the small intestine, fusiform, ribbon-like thinning of the intestinal wall, or oval dilatation with eccentric but centrally projected channel formation. Barium studies may demonstrate an adjacent area of partial obstruction. Retroperitoneal masses also may closely approximate the bowel wall, causing elongation and compression of the adjacent loops, and at times so mimic mesenteric masses that differentiation is impossible.

Teratomas, dermoid cysts of the ovaries, and ovarian cysts confined in the pelvis will frequently simulate tumors of retroperitoneal origin arising adjacent to the pelvic structures. The teratomas and dermoid cysts may show characteristic calcifications, dental structures, or, in the upright position, radiolucent layering attributable to the presence of fat or sebaceous material.

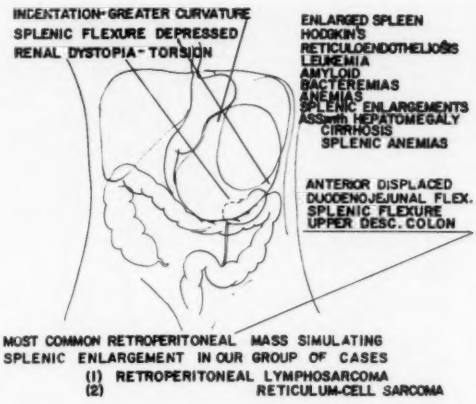


Fig. 8. Common causes of splenic enlargement which may mimic a retroperitoneal mass in the left upper quadrant. The area of overlap adjacent to the margins of the inferior mesial position of the spleen and the greater curvature aspect of the stomach are demonstrated, with the associated organ displacement produced by mass lesions in this region.

The growth of masses of renal or adrenal origin may be associated with anterior displacement of the duodenojejunal junction, the ascending colon, or the descending colon. The proximate loops of small bowel may also be displaced anteriorly. The presence of lateral, superior or inferior displacement is a function of the precise location of the mass and the course of least resistance to its development. Nephrotomography, retroperitoneal pneumography, or aortography is often required to establish the identity of these masses and their relationship to the normal retroperitoneal structures.

In children, the most common neoplasm in this site is Wilms' tumor, and this can be expected to displace loops of small intestine anteriorly. Visualization of the deformed calyceal system and of the displaced, distorted renal pelvis may be accomplished by retrograde or intravenous pyelography. This is usually sufficient for diagnosis, in view of the statistical likelihood of Wilms' tumor within this age group. In the adult, a renal carcinoma may present signs almost exactly similar to those found with the Wilms' tumor.

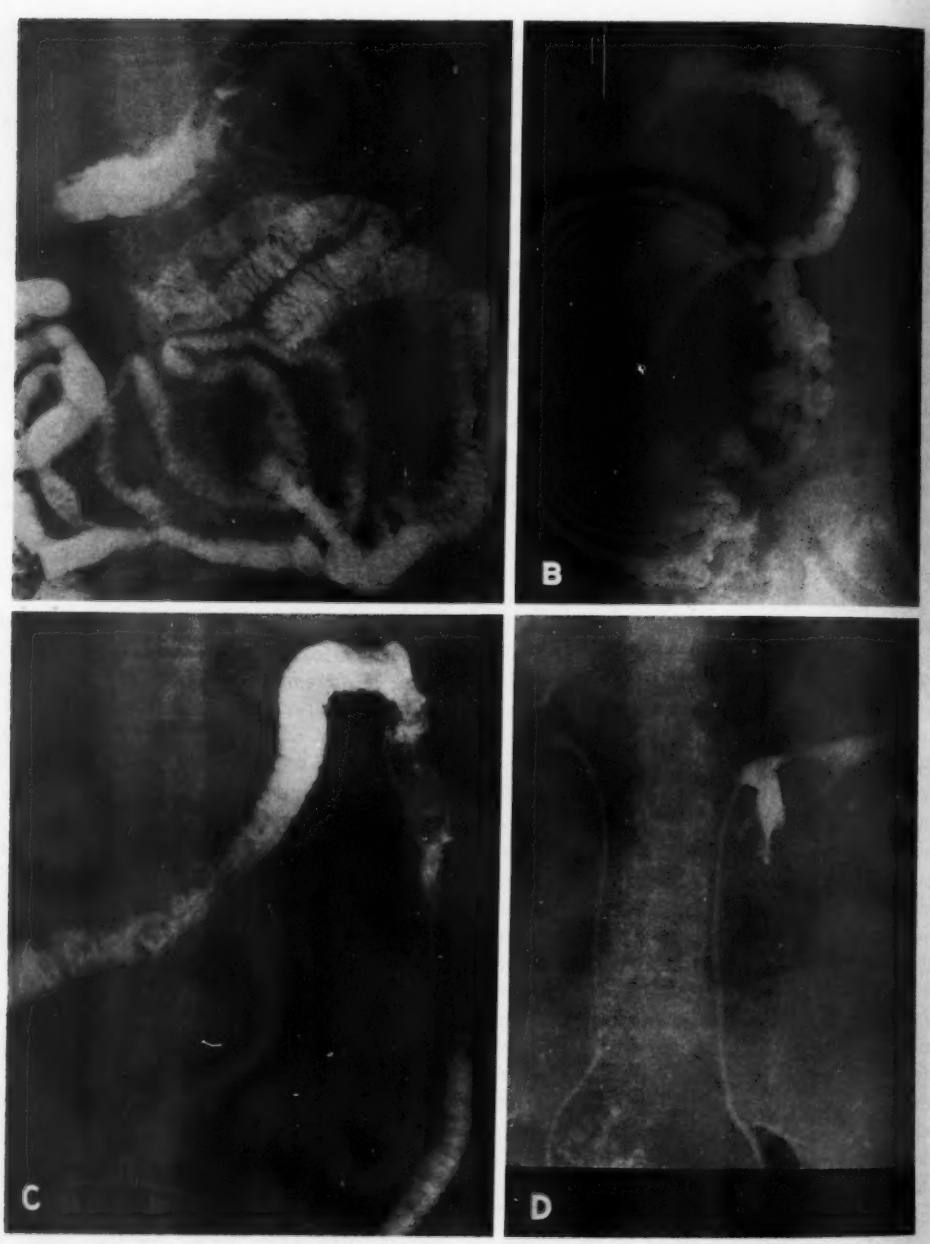


Fig. 9. Effects of expansion of a retroperitoneal mass lesion in the form of a cyst of the lower pole of the left kidney upon the surrounding structures. A. Unfolding of the small bowel loops. B. Anterior displacement of the midportion of the descending colon. C. Lateral displacement of the middescending colon without evidence of intrinsic bowel involvement. D. Renal torsion and displacement produced by the cyst.

Calcification of a nonspecific character may occasionally be noted in this region, aiding in identification of the mass.

The neuroblastoma sympathicum is the second most common abdominal neoplasm of childhood. Calcification within this

Fig. 10. Y. D., 61-year-old woman with malignant hypertension. The barium contrast studies (A and B) demonstrate a well defined left upper quadrant mass producing indentation phenomena on the greater curvature of the stomach in association with distortion of the adjacent portions of the duodenojejunal flexure. Although the flexure is displaced downward and mesially in the anteroposterior views, in the lateral view there is only minimal significant anterior displacement. The large mass has produced anterior displacement of the partially filled stomach.

Pyelography (C) demonstrated marked distortion of the calyces of the left upper pole. At surgery a well defined pheochromocytoma was demonstrated. Extensive calcific deposits in the region of the pelvic inlet were associated with a large uterine myoma.

These films should be compared with those shown in Figs. 2 and 3. Note that the mass displacements seen in the region of the left midquadrant are again nonspecific in character. Identification in this case was significantly aided by the laboratory findings and additional roentgenographic studies.

tumor is common and serves as a distinguishing feature. In contradistinction to Wilms' tumors, these lesions are most likely to be associated with a nonfunctioning kidney on the involved side, demonstrable by pyelography. It is not unusual for this highly invasive and rapidly growing tumor to extend behind the duodenojejunal flexure, producing anterior displacement of this junction and of other retroperitoneal structures.

The third most common retroperitoneal tumor of childhood is the teratoma. While this occurs most frequently in the

Fig. 11. R. J., a 50-year-old man with liposarcoma. An area of increased density in the region of the right midquadrant, with extensive displacement of the contiguous margins of the hepatic flexure and significant anterior displacement of the ascending colon. Obliteration of the adjacent psoas margin was not associated with displacement of the kidney or distortion of the renal contour. The large, well defined, rounded mass was expansive but not infiltrative. The tumor found at operation was characteristic of the 50 per cent of retroperitoneal liposarcomas which are myxolipomatous and fibrolipomatous in character. It must be stressed that only one-half of the total number of lipomas possess the physical characteristics necessary to produce specific signs of a lipomatous tumor in this area.

sacrococcygeal area, it is often manifest in the paravertebral area and may be situated high in the midabdomen, close to the pancreas and kidney. Roentgenographically, masses in this area displace the small intestinal loops anteriorly and centrifugally. The retroperitoneal teratomas may contain areas of calcification which may be spotty and irregular or simulate mature bone formation. Rarely, an included twin or *fetus in fetu* may be shown, with a high degree of differentiation. Unlike Wilms' tumor, the teratoma does not cause extensive distortion or invasion of the renal pelvic or calyceal system. The type of displacement of the bowel loops in these regions is nonspecific, and retroperitoneal pneumography may be necessary to demonstrate that the teratoma is unattached to other structures.

A renal cyst will be apparent as a smooth, rounded mass, which may cause displacement of the descending colon, as in the case illustrated in Figure 9. Polycystic kidneys frequently produce bilateral enlargements which, in turn, may cause pronounced displacement of the adjacent bowel loops.

Pheochromocytoma and the benign ganglioneuromas are tumors of the adrenal medullary tissues not likely to be found in children. Clinical evidence of intermittent hypertension and the presence of other laboratory findings are more reliable indicators for the diagnosis of pheochromocytoma than are usually offered by roentgenography (Fig. 10). Adrenal cortical tumors which produce masculinization and advanced skeletal development may rely on these clinical factors for their more exact distinction.

Pancreatic cysts, pseudocysts, and the relatively rare cystadenocarcinoma of the pancreas should be considered at this point, since they are relevant to the roentgenographic differentiation of masses

in the region of the kidneys and the adrenals. The gastrocolic type of cyst may be of two varieties: One enlarges between the stomach and the proximal transverse colon, and the other between the stomach and the distal transverse colon. The mesocolic type of cyst enlarges in the region of the mesocolon below the margins of the transverse colon. Gastropneumography and measurements of the retrogastric space are valuable tools in evaluating the findings in these areas.

Lymphomas involving the retroperitoneal nodes may simulate local enlargements of the pancreas, producing similar enlargement of the duodenal loop, separation of the stomach from the transverse colon, and anterior displacement of the body of the stomach or of the duodenojejunal flexure. The presence of nodular masses beyond this region, particularly in the mediastinum, may occasionally assist in the roentgen differentiation.

Fibrosarcomas or rhabdomyosarcomas are rare retroperitoneal tumors which may attain a large size. In the majority of such cases the roentgen findings are nonspecific. The rhabdomyosarcoma is highly malignant and frequently presents metastases at the time of discovery of the primary lesion or even earlier.

The retroperitoneal liposarcomas and lipomas may present certain characteristics which are specific to the extent that they may be regarded as basic considerations for additional diagnostic studies. The lipomatous mass produces displacement of the abdominal viscera without evidence of an intrinsic organic lesion or involvement of the intestinal wall. If the tumor is expansive and noninfiltrative, there may be increased radiolucency of the areas previously occupied by intestinal loops. Only 50 per cent of the lipomatous tumors contained in the retroperitoneal area, however, possess the physical characteristics necessary to produce specific roentgen signs (Fig. 11).

In the region of the pelvis, the forward displacement of the rectum is significant

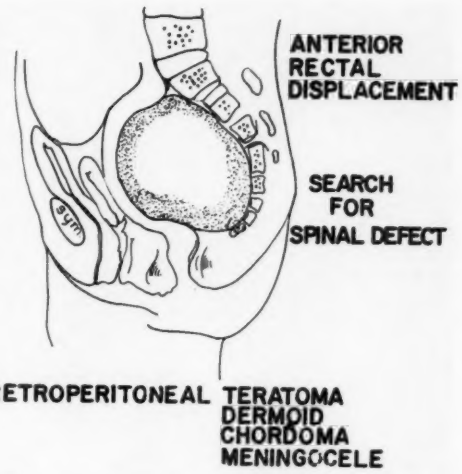


Fig. 12. Masses in the retrorectal region. Schematic drawing showing significant anterior displacement of the large bowel produced by retrorectal masses. Usually a mass associated with anterior rectal displacement is typical of a tumor of retroperitoneal origin. A search for a spinal defect should be made in order to exclude an anterior sacral meningocele. Ackerman (1) has recorded extensive irregular calcifications contained in malignant schwannomas occurring in this area. Tumors of the retroperitoneum arising from functioning and nonfunctioning paraganglionic tissues have also been reported.

and in most cases diagnostic of a retroperitoneal mass (Figs. 12 and 13). Such masses may represent teratomas, dermoids, chordomas, or meningoceles. A pelvic retroperitoneal mass associated with a defect in the lumbar spine or sacral portion of the spine is characteristic of an anterior meningocele.

Inflammatory retroperitoneal masses may at times arise in the pararenal area. Perinephric abscesses may gravitate down the iliopsoas muscle to point in the inguinal region. Perforation into the retroperitoneal area in appendicitis or diverticulitis may occur. While such lesions may be confined to the regions of the cecum or sigmoid, displacement of these structures can be recorded roentgenographically. Abscesses may occur in any part of the intraperitoneal or retroperitoneal area. In such cases, significant information can be obtained by analysis of the signs of abscess formation in these sites and the displacement of the adjacent structures.

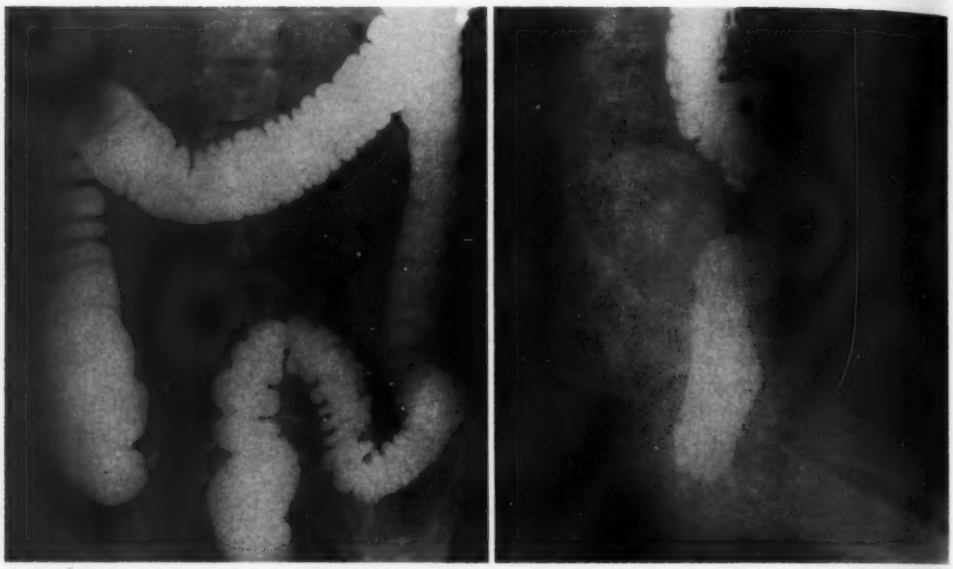


Fig. 13. Retrorectal dermoid cyst in a 26-year-old male. Anterior displacement of the rectum is observed on the lateral film study.

DISCUSSION

In the preceding pages we have elaborated a method of roentgen diagnosis of abdominal masses and retroperitoneal tumors based upon an analysis which takes into account four factors influencing interpretation of the topographic anatomy. Each mass may exhibit general roentgen characteristics suggesting clues to its identity and structure. In some instances it will manifest additional features so specific as to permit a complete diagnosis. Since, among the many tumors, some are more likely to develop in one region than another, approximate localization of any mass will provide further indication as to its possible type. Finally the imprint of the tumor upon surrounding structures can be demonstrated by barium contrast studies, providing a gauge of its gross anatomic behavior.

At all times it must be remembered that barium studies may indicate only the size and the relative location of a mass, yielding no additional information, whether the site is intraperitoneal or extraperitoneal. Despite these limitations, careful analysis of the data obtained from such examinations may afford a surprising amount of information. Specific diagnosis of abdominal and retroperitoneal masses often cannot be made from the simple roentgen findings alone, and correlation with laboratory, clinical, and other roentgen data will be necessary.

It is only at this point that more complex studies may be warranted. They are not justified simply to supplement what can be learned by the history, physical examination, laboratory studies, and the relatively innocuous roentgen procedures. To repeat our earlier warning: pneumography and the special contrast injection technics are the big guns in the armamentarium of the radiologist in his attack on this problem. Their wasteful, indiscriminate and premature use depreciates their value and at times increases their danger.

SUMMARY

The role of barium contrast studies in the evaluation of retroperitoneal tumors has been assessed. Much information may be obtained from careful analysis of

this commonly used roentgenographic procedure.

Utilization of the lateral view in simple roentgenography and in contrast studies, to evaluate the position of certain fixed points in the abdomen, may determine the retroperitoneal position of an abdominal mass.

Barium contrast studies should be used as a pivotal point, in determination of the necessity for additional examinations. The limitations of the barium study are reviewed.

Grace-New Haven Community Hospital
789 Howard Ave.
New Haven 4, Conn.

REFERENCES

1. ACKERMAN, L. V.: Tumors of Retroperitoneum, Mesentery, and Peritoneum. Atlas of Tumor Pathology, Section VI, Fascicles 23, 24. Washington, D. C., American Registry of Pathology: Armed Forces Institute of Pathology, 1954.

2. ARNHEIM, E. E.: Retroperitoneal Teratomas in Infancy and Childhood. Pediatrics **8:** 309–327, September 1951.

3. BERSACK, S. R., IOVINE, V. M., AND TIEVSKY, G.: Lipomas of the Mesentery of the Small Intestine. Radiology **56:** 850–855, June 1951.

4. BROWN, S.: Differential Diagnosis of Abdominal Tumors by the Roentgenological Method. Radiology **10:** 48–56, January 1928.

5. BROWN, S.: The Radiological Study of the Stomach and Duodenum, with Special Reference to the Value of the Lateral View. Radiology **17:** 85–98, July 1931.

6. CAPURRO, F. G., AND BLANCO, R. P.: Semiologia clinico-radiologica de las tumoraciones abdominales. Montevideo, Uruguay, A. Monteverde & Cia, 1946.

7. CASE, J. T.: Roentgenology of Pancreatic Disease. Caldwell Lecture, 1939. Am. J. Roentgenol. **44:** 485–518, October 1940.

8. DONNELLY, B. A.: Primary Retroperitoneal Tumors; Report of 95 Cases and Review of the Literature. Surg., Gynec. & Obst. **83:** 705–717, December 1946.

9. DONHAUSER, J. L., AND BIGELOW, N. H.: Primary Retroperitoneal Tumors: An Analysis of 48 Cases. Arch. Surg. **71:** 234–238, August 1955.

10. ENGEL, A., AND LYSHOLM, E.: New Roentgenological Method of Pancreas Examination and Its Practical Results. Acta radiol. **15:** 635–651, 1934.

11. ENGEL, W. J.: Classification of Retroperitoneal Tumors as a Guide in Clinical Diagnosis. Arch. Surg. **70:** 156–160, February 1955.

12. EVANS, J. A., AND POKER, N.: Newer Roentgenographic Techniques in the Diagnosis of Retroperitoneal Tumors. J.A.M.A. **161:** 1128–1132, July 21, 1956.

13. FISHBACK, H. R., JR.: Renal Dystopia Due to Intra-Abdominal Masses with a Review of the Literature and Report of 5 Cases. Am. J. Roentgenol. **52:** 521–528, November 1944.

14. GOLDEN, T., AND STOUT, A. P.: Smooth Muscle Tumors of the Gastrointestinal Tract and Retroperitoneal Tissues. Surg., Gynec. & Obst. **73:** 784–810, December 1941.

15. HANSMANN, G. H., AND BUDD, J. W.: Massive Unattached Retroperitoneal Tumors; Explanation of Unattached Retroperitoneal Tumors Based on Remnants of Embryonic Urogenital Apparatus. J.A.M.A. **98:** 6–10, Jan. 2, 1932.

16. MENDILLO, A. J., LOWMAN, R. M., WATERS, L. L., AND STANLEY, H. W.: Mesenteric Chylous Cysts: Associated Diagnostic and Surgical Problems. J Internat. Coll. Surgeons **18:** 265–290, September 1952.

17. MESCHAN, I., ET AL., The "Normal" Radiographic Adult Stomach and Duodenum: Study of Their Contour and Size and Their Critical Relationships to Spine in Both Symptomatic and Asymptomatic Individuals. South. M. J. **46:** 878–887, September 1953.

18. MCCULLOUGH, J. A. L., AND SUTHERLAND, C. G.: Intra-Abdominal Calcification: The Interpretation of its Roentgenologic Manifestations. Radiology **36:** 450–457, April 1941.

19. MORTON, J. J.: Organ-Displacing Abdominal Tumors. Ann. Surg. **133:** 665–683, May 1951.

20. NEWMAN, H. R., AND PINCK, B. D.: Primary Retroperitoneal Tumors: Summation of 33 Cases. Arch. Surg. **60:** 879–896, May 1950.

21. NICE, C. M., JR., MARGULIS, A. R., AND RIGLER, L. G.: A Simple Approach to the Roentgen Diagnosis of Abdominal Tumors in Infants and Children. Am. J. Roentgenol. **75:** 977–993, May 1956.

22. PACK, G. T., AND TABAH, E. J.: Collective Review: Primary Retroperitoneal Tumors; A Study of 120 Cases. Internat. Abstr. Surg. **99:** 209–231; 313–341, 1954; in Surg., Gynec. & Obst., September and October 1954.

23. RIGLER, L. G.: Diagnosis of Extra-Gastro-Intestinal Abdominal Masses. Radiology **21:** 229–238, September 1933.

24. SCHATZKI, R.: Roentgenological Diagnosis of Primary Carcinoma of the Liver. Am. J. Roentgenol. **46:** 476–483, October 1941.

25. SHAMBAUGH, P.: Displacements of the Left Kidney in the Diagnosis of Tumors of the Left Flank and Abdomen. Radiology **26:** 335–339, March 1936.

26. SHEINMEL, A., AND MEDNICK, E. A.: The Roentgen Diagnosis of Upper Abdominal Retroperitoneal Space-Occupying Lesions. Am. J. Roentgenol. **65:** 77–92, January 1951.

27. SHERMAN, R. M., CAYLOR, H. D., AND LONG, L.: Anterior Sacral Meningocele. Am. J. Surg. **79:** 743–747, May 1950.

28. STOUT, A. P.: Quoted by Ackerman (1).

29. WIESE, H. W., AND LARIMORE, J. W.: Roentgenology of Extra-Alimentary Tumors. Am. J. Roentgenol. **27:** 383–404, March 1932.

30. WINDHOLZ, F.: Roentgen Diagnosis of Retroperitoneal Lipomas. Am. J. Roentgenol. **56:** 594–600, November 1946.

(Pro le summario in interlingua, vider le pagina sequente)

SUMMARIO IN INTERLINGUA

Le Rolo De Studios A Contrasto Per Barium in Le Diagnose De Tumores Retroperitoneal

Ab le puncto de vista del roentgenologo, le concepto "tumores retroperitoneal" deberea esser interpretate como coperiente omne massa intra le spatio retroperitoneal. Proque le canal gastrointestinal—in consequentia de su extension in quasi omne region del abdomine—es afficite con alte grados de probabilitate per omne massa expansive in le areas non solmente intrased etiam retroperitoneal, le studios a contrasto per barium que es communmente usate in le examine de ille canal es equalmente de valor in le demonstration e evalutation de massas retroperitoneal. Tal investigationes pote excluder le presentia de intrinsec lesiones gastrointestinal, revelar le presentia de massas non suspicite, delinear massas abdominal que es cognoscitemente presente, e determinar le necessitate de studios subsequente.

Methodos de examine directe—*i.e.* le methodos del pneumographia retroperitoneal, del aortographia, del venographia, e del nephrotomographia—deberea esser utilisate solmente post le effectuation de precise studios de pelliculas abdominal simple, de roentgenogrammas a contrasto per barium, e de pyelogrammas. Le uso prematur de plus complexe methodos reduce lor valor e augmenta lor hasardos.

Le sequente synopse es discutite in detalio como guida de utilitate in evalutar massas trovate in le area retroperitoneal: (a) Omne massa individual possede possibilemente general characteristicas roentgenographic que pote servir como indices in determinar su identitate e su structura. (b) In certe casos, aspectos roentgenologic additional es tanto specific que illos offere un diagnose complete. (c) Proque certe tumores se disveloppa con plus alte grados de probabilitate in un region que in un altere, le localisation de un massa provide information de valor diagnostic additional. (d) Le impression que le tumor effectua in le structural circumjacente pote esser observate e evalutate como indice de su grossier comportamento anatomic.

Finalmente, le limitationes del methodo in consideration es passate in revista.

Renal Cancer: Translumbar Arteriography for Its Recognition[1]

ARTHUR T. EVANS, M.D.

In 1949, when we embarked upon our first studies of translumbar arteriography, the prevailing thought in this country regarding needle puncture of the aorta in human subjects was not favorable, and we approached the problem with a certain anxiety. This was in sharp contrast to European surgeons, who had shown little hesitancy in utilizing this technic, the essential safety of which (when properly carried out) had been widely accepted. In Europe today, despite reports of isolated accidents and undesirable side-effects, arteriography is taken for granted, being performed as routinely as pyelographic studies in our own hospitals. In the United States, on the other hand, passage of almost a decade since my first attempts has brought no universal shift in opinion as to the value and safety of translumbar arteriography in the diagnosis of tumors and cysts of the retroperitoneal space as well as other urological lesions.

With the technic originally presented by the writer (1), we have continued to have morbidity of a considerably lesser degree than from retrograde pyelography. We have had no fatalities, which is appreciably more than can be said for the use of antibiotics. Especially surprising is the rejection of arteriography as a diagnostic tool on the grounds that it is of questionable value; it is criticized for producing films that are ambiguous and too dependent upon subjective interpretation. In this respect, I am reminded of what Bazin, the eminent French urologist, remarked a generation ago in defense of a technic new at that time and under fire from its critics. He denied that pyelography made mistakes. Urologists, not the films, were at fault. The facts were there to be read by those who could read correctly.

Undeniably, experience counts for something in arteriography, both in the taking of the films and their subsequent interpretation. We have regularly utilized this procedure on the urological service of the Christ and Cincinnati General Hospitals for the past seven years. The total number of our aortic punctures is now over 2,500, and we have yet to encounter anything more distressing than minimal morbidity as a result of the procedure (2, 3). To reiterate, we have had no deaths, no known cases of intrarenal arterial thrombosis have occurred, no patient has had a resultant paralysis or other evidence of nerve damage, nor have we had any complications within the intestinal arterial tree. Hemorrhage from the puncture site has never been noted to produce more than transient pain (4).

As a physician, I have a responsibility to my patients and I do not expect to expose them to serious or lasting trauma. Further, if a patient is not an acceptable risk for arteriographic study by our technic, he is not usually acceptable for renal exploration. We did not lightly enter upon the practice of this diagnostic aid. First, we satisfied ourselves as to its basic safety by aortic puncture in moribund patients, whose cadavers were later studied for possible ill effects. None were found (3). Moreover, we undertook to study each aspect of the problem as the work progressed. Considerable intra- and interdepartmental discussion aided in the satisfactory utilization of this technic. We are grateful to other urologists who have contributed to the study of the safety of translumbar arteriography. For the attainment of maximum safety, I feel that it is important to observe the following rules: (*a*) injection of not more than 15 c.c. of contrast

[1] From the Urological Service of The Christ and The Cincinnati General Hospitals, Cincinnati, Ohio. Presented as part of a Symposium on Contrast Media in the Diagnosis of Retroperitoneal Abnormalities, at the Forty-Second Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2-7, 1956.

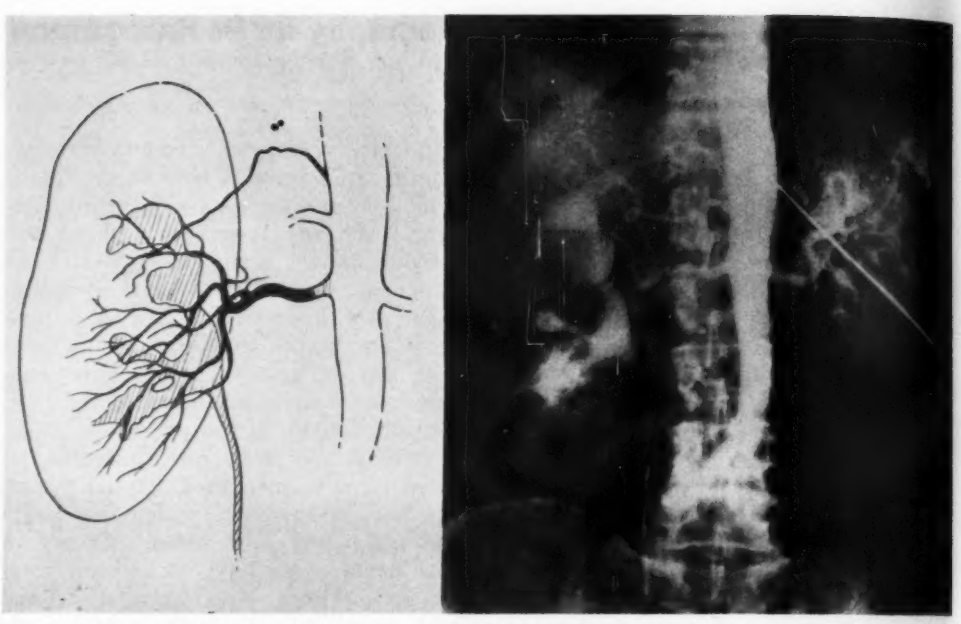


Fig. 1. Solitary cyst of the right kidney, crossed by the thoracic artery and renal arteries, making it only partially avascular. (We do not advocate combining pyelography and arteriography.)

media in one dose, and that only once in twenty-four hours; (*b*) only one puncture of the aorta at a time, with a needle no larger than 18-gauge; (*c*) the use of an iodide compound (5) of the type used for intravenous urography; (*d*) injection of the aorta above the celiac plexus.

Our failure to abandon translumbar arteriography, after having utilized it for seven years, reflects the confidence we place in it as a reliable diagnostic tool. A recent review of our films serves to highlight the various salient factors that must be borne in mind if proper use is to be made of arteriograms in the diagnosis of space-consuming lesions of the renal parenchyma.

For effective differentiation of cysts and tumors of the kidney, satisfactory arteriograms are required. This sounds too axiomatic for mentioning. Yet we find all too frequently that an attempt at diagnosis is made on the basis of improperly executed roentgenograms. The film that does not demonstrate good and nearly complete filling of the terminal arteries of the kidney often is not suitable for use in making a diagnosis. Study of an inadequate arteriogram may lead to an incorrect diagnosis and consequent mistrust and dissatisfaction with a valuable procedure. Furthermore, if there are several renal arteries, it is necessary that all of them be filled, not only one.

Arteriography is the most refined diagnostic tool in the entire armamentarium of the urologist and roentgenologist for the recognition and differentiation of renal cysts and tumors. Pyelography and retroperitoneal air studies do not afford accurate differentiation. However, in the utilization of arteriography for this purpose, there are a number of prerequisites to a satisfactory end-result. A knowledge of the normal arterial pattern of the kidney is basic, and the pathologic changes possible within a kidney must be known from both gross and microscopic study.

The arterial pattern of a cyst within the kidney, demonstrated arteriographically, is one in which vascularity is lacking. Departures from this rule may, however, be observed, as illustrated in Figure 1. Renal cysts are certainly avascular, but extrarenal vessels, which are visualized by the

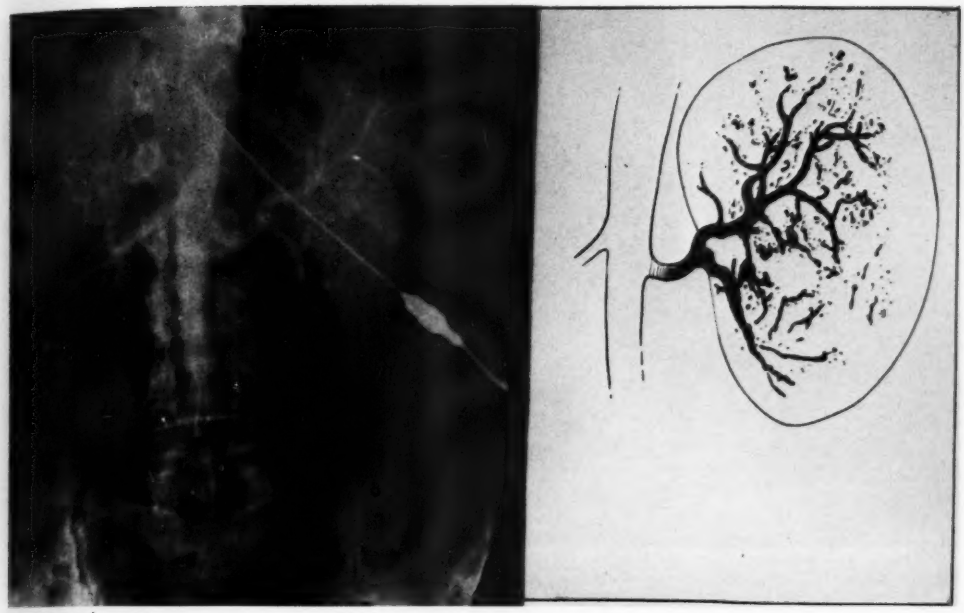


Fig. 2. Typical arterial pattern of tumors: increased vascularity; irregular vascular caliber; bizarre directions

technic, may traverse the cystic area of the kidney and lead to confusion. For example, the thoracic, branches of the hepatic or splenic, the gastric, and at times the phrenic arteries may overlie the renal area. For proper interpretation and true evaluation, time must be taken to trace all renal area arteries to their origin. This is not always easily accomplished. In addition; one knows, from a gross study of renal cysts, that normal kidney substance is frequently present anterior or posterior to the cyst. This permits demonstration of some intrarenal arteries crossing the cystic area in the arteriogram taken in the anteroposterior plane. In the last analysis, it is often the degree of vascularity and not the absence or presence of vessels that identifies a renal cyst. The arteriogram of the renal circulation requires study and thought, and certainly correlation with the pyelogram, as well as a basic knowledge of the pathologic lesions possible. Equally, a knowledge of the normal anatomy and normal arteriogram is essential to proper diagnosis.

The viable portions of renal-cell carcinomas are always quite vascular microscopically. When seen on an arteriogram, this increased vascularity in a portion of a kidney is pathognomonic of renal neoplasms. The increase is actually twofold, an increase in vessel number as well as in vessel caliber. This feature must be searched for carefully in each renal arteriogram. We make a practice of sitting down in a quiet viewing room to study the film carefully, tracing all arteries from their origin at the renal artery or aorta to their terminus in or around the kidney. It takes more than a hasty glance to determine with accuracy the presence or absence of increased vascularity. A knowledge of the normal circulation must be well established in the mind, if an increased vascular supply is to be recognized.

The second feature of the arterial pattern of renal parenchymal cancer is the irregular vascular caliber (Fig. 2). The caliber of individual vessels within the viable renal neoplasm varies atypically from segment to segment. The vessel may be small for the distance of a millimeter, increasing in caliber slightly, and

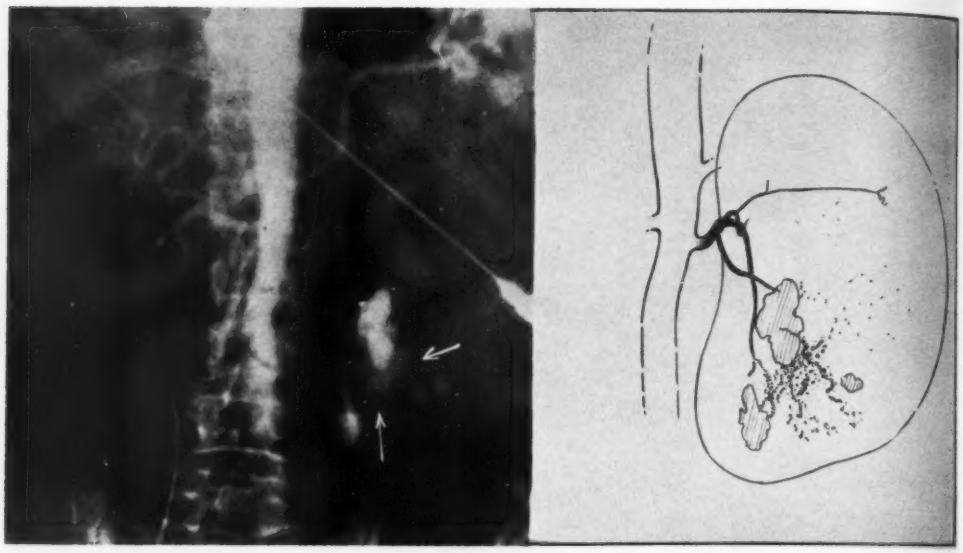


Fig. 3. Large left renal-cell carcinoma with associated stones. The tumor was 90 per cent necrotic; yet in the remaining viable portion typical increased vascularity and an irregular vascular pattern are present.

then, more distally, fanning out to a smudge with or without a sharp outline. This latter characteristic has been referred to variously as a puddling, laking, pooling, and tumor stain. In addition to the constantly varying caliber of the vessels, there are bizarre changes in direction not seen normally. While these may be slight and not striking in appearance, nevertheless this aberration is constant. Both the change in caliber and the altered direction of the vessels are probably the result of pressure from rampant cellular growth adjacent to the arteries. Correlation of the microscopic appearance of renal parenchymal cancer with the smudging seen on the arteriogram leads me to believe that this arterial change is due to large arteriovenous sinuses within the neoplasm.

The third feature probably accounts for most errors in diagnosis. Unfortunately, many renal-cell neoplasms are quite large before presenting symptoms. As a result, much of the mass may be necrotic, grossly and microscopically, before the urologist investigates the kidney. This necrosis obviously distorts the two pathognomonic characteristics of the renal arteriogram mentioned above. While it does not normally involve the entire neoplasm, as much as 90 per cent of a large carcinoma may be necrotic. Upon hasty superficial examination of the arteriogram, this aberration may lead to a false impression of the presence of an avascular renal area and, therefore, to a diagnosis of cyst (Fig. 3).

Careful inspection of the periphery of the renal substance and/or mass will reveal in the area of viable tumor tissue the presence of one or the other, or both, of the previously mentioned pathognomonic changes of renal parenchymal neoplasm. One of my patients showed typical arterial changes only in the perinephric area, for the remainder of the large tumor was necrotic. In another instance, vascular irregularity was demonstrated in the renal vein, into which the renal-cell carcinoma had extended. If, therefore, satisfaction is to be obtained from the use of arteriograp in the diagnosis of renal tumors, be they cysts or neoplasms, a painstaking and somewhat time-consuming examination of the translumbar arteriogram must be undertaken.

Tumors arising from the renal pelvis, unless extensive and invading the renal parenchyma, cannot be detected by arteriography under normal circumstances. We have not utilized this diagnostic tool in adenomyosarcoma of the kidney. Neither have we had an opportunity to visualize the arterial tree of a true sarcoma or an adenoma of the kidney. The smallest kidney tumor demonstrated by us was a renal-cell carcinoma 1.0 cm. in diameter, at the lower pole of the right kidney. Its presence was not realized on the pyelogram, but it was diagnosed from the arteriogram and proved at surgery.

It has been reported recently (6) that 7 per cent of serous or clear renal cysts present neoplastic proliferations. In our entire series, we have never encountered such a case. It is also stated that 25 per cent of hemorrhagic renal cysts harbor malignant elements. In our series, however, there was but a single hemorrhagic cyst. Arteriographic study in this case revealed a mass in the left side of the abdomen, attached to the kidney, displacing the renal vessels upward. Since the mass was avascular, it was interpreted as a large cyst at the lower pole of the left kidney, and at operation a large blood-filled cyst was excised. Grossly and microscopically, the cyst wall revealed no neoplasm. In the light of our own experience, we cannot agree that the occasional occurrence of a simple cyst with malignant changes in its wall should in any way invalidate arteriography as a means of differentiating between cysts and tumors. If there is a tumor arising from the cyst wall, arteriography can be expected to reveal it.

Our present series of cysts and tumors of the renal parenchyma comprises 236 cases in which arteriography was employed as a diagnostic measure. The great majority of the subjects were seen at the Christ and Cincinnati General Hospitals. A lesser number of patients were seen at other hospitals in the vicinity. According to the diagnosis obtained by arteriographic study, there were 126 tumors and 108 cysts (Table I). All but 2 of the patients with a diagnosis of renal tumor were operated upon. Bone roentgenograms and arteriograms revealed renal tumors with widespread skeletal metastases in these 2 patients. No autopsy was obtained in either case and they have therefore been deleted from the statistics. Of the 126 operative cases, the diagnosis of tumor established by arteriography was confirmed by microscopic pathological examination in 120 subjects. The six erroneous diagnoses have been summarized in order to demonstrate what has been emphasized above, that is, the need for painstaking scrutiny of properly executed arteriograms.

TABLE I: ACCURACY OF ARTERIOGRAPHIC DIAGNOSIS

Malignant neoplasms of renal parenchyma diagnosed by arteriography		
No. of cases		128
Not proved	2	
Proved	126	
Cancer diagnosed as cyst		3
Cancer not diagnosed		2
Percentage of accuracy		95.2%
Renal cysts diagnosed by arteriography		
No. of cases		108
Unoperated	26	
Proved	79	
Cancer diagnosed as cyst	3	
Percentage of accuracy		96.3%

In one patient a diagnosis of tumor was made from the arteriogram, but exploration of the kidney revealed no abnormality. The arteriograms of another patient, made early in the series, show an insufficient amount of arterial filling, by present standards, for proper interpretation. In this instance the space-consuming lesion was erroneously diagnosed as a cyst, but surgical exploration revealed a tumor. Two patients showed no vascular changes typical of tumors on the arteriogram but, when explored, were found to have tumors. In the remaining 2 cases cysts were diagnosed preoperatively because of the avascularity demonstrated on the arteriogram. Pathologic reports, however, revealed tumor with central necrosis. Review of these films now indicates the presence of peripheral circulatory changes typical of tumor. Originally, we misinterpreted the

central changes and failed to recognize those at the periphery.

In our entire series, the results indicate an accuracy of 95.2 per cent. One gratifying finding is that our mistakes were made early in the study, before we were completely familiar with its possibilities. Further, this degree of accuracy is far greater than can be obtained from other procedures. Diagnosis is still one of the arts of medicine.

In our series of renal masses, we made a diagnosis of solitary cyst in 108 patients. Of this group, 82 were explored. Three patients had no renal cyst, but a renal tumor as presented above. In the remaining 79, a solitary renal cyst was found. Thus, 96.3 per cent were correctly diagnosed. Twenty-six patients were not operated upon. Four of this number died from other causes and no autopsy was obtained. Six patients were without evidence of urinary disease on pyelography, bone and/or chest roentgenography three to six years after the original diagnosis of solitary cyst. Another group of 4 patients are well but with urological complaints referable to the lower urinary tract (trigonitis, urethritis, prostatitis). Sixteen patients have been lost to follow-up. In 1 patient, studied in 1953, a diagnosis of solitary renal cyst was made. He was operated upon elsewhere within the last month by a urologist (for unknown reasons), and the kidney was reported to be without abnormality. Because of the lapse of time—over three years—since our study, I am reluctant to include this patient in our statistics.

SUMMARY

We have utilized arteriography of the translumbar type for seven years to study tumors of the renal parenchyma. We do not feel that it is of value in diagnosing tumors of the renal pelvis, nor have we had any experience with the arteriographic diagnosis of Wilms' tumors or sarcomas of the kidney.

One hundred and twenty-six cases were diagnosed arteriographically as renal neoplasm. Subsequent operation showed the diagnosis correct in 95.2 per cent. In 82 proved cases diagnosed as solitary renal cyst the accuracy was 96.3 per cent; 3 cases proved to be cancer. Experience has increased our accuracy, so that in the last three years, arteriographic study has proved to be 100 per cent correct. We have had no fatalities incident to the examination, and no significant morbidity.

When this simply performed procedure is utilized wisely, it is a worthwhile diagnostic tool.

1908 Union Central Bldg.
Cincinnati 2, Ohio

REFERENCES

1. EVANS, A. T.: Translumbar Arteriography. A Preliminary Report. Cincinnati J. Med. **32:** 47–56, February 1951.
2. SMITH, P. G., RUSH, T. W., AND EVANS, A. T.: The Technique of Translumbar Arteriography. J.A.M.A. **148:** 255–258, Jan. 26, 1952.
3. SMITH, P. G., RUSH, T. W., AND EVANS, A. T.: Evaluation of Translumbar Arteriography. J. Urol. **65:** 911–923, May 1951.
4. MCAFEE, J. G., AND WILLSON, J. K. V.: A Review of the Complications of Translumbar Aortography. Am. J. Roentgenol. **75:** 956–970, May 1956.
5. MELICK, W. F., AND VITT, A. E.: Present Status of Aortography. J. Urol. **60:** 321–334, August 1948.
6. GIBSON, T. E.: Interrelationship of Renal Cysts and Tumors; Report of 3 Cases. J. Urol. **71:** 241–252, March 1954.

SUMMARIO IN INTERLINGUA

Cancere Renal: Arteriographia In Su Recognition

Arteriographia es le plus raffinate instrumento diagnostic in existentia pro le recognition e differentiation de cystes renal e de tumores del parenchyma renal. Illo non es considerate como utile in le diagnose de tumores del pelve renal; e le autor ha nulle experientia con su uso in casos de tumor de Wilms o de sarcoma.

In general, cystes pote esser recognoscite per le absentia in illos de vascularitate, ben que in casos sporadic, vasos extrarenal o vasos veniente ab le adjacente normal sub-

stantia renal es a vider in arteriogrammas, transversante le area cystic.

Neoplasmas renal, como regula general, pote esser recognoscite per le augmento de lor vascularitate, ben que in le presentia de necrose excessive, iste facto pote escappar al observation si on neglige facer un exactissime studio del areas viabile. Le vasos es non solmente plus numerose; etiam lor calibre es augmentate. Le calibre es irregular, e le direction sequite per le vasos es alterate.

Cento vinti-sex casos esseva diagnosticate arteriographicamente como neoplasma renal. Le operation subsequente, con studio microscopic, confirmava le diagnose in 120 casos. Isto es un exactitude de 95,2 pro cento. Un diagnose arteriographic de cyste renal esseva facite in 108 patientes. Octanta-duo de istes esseva operate, e le diagnose esseva confirmate in 79 (*i.e.* in 96,3 pro cento). In le remanente 3, un tumor renal esseva trovate.

Arteriographia ha essite empleate depost septe annos, sin mortalitate e sin grados significative de morbiditate.

The Diagnosis of Adrenal Neoplasms by Contrast Media[1]

HOWARD L. STEINBACH, M.D., FRANK HINMAN, Jr., M.D., and PETER H. FORSHAM, M.D.

PLAIN ROENTGENOGRAMS of the abdomen will frequently demonstrate normal adrenal glands as small triangular or semilunar shadows outlined by fatty areolar tissue. In some instances, tomography, by diminishing the confusing overlying shadows, will outline adrenals which are not shown on plain films. We have not been very successful with either plain films or tomography for the diagnosis of adrenal diseases which produce only minimal changes in the size of the gland. In many cases, particularly if the adrenal glands are abnormal, it becomes necessary to employ a contrast medium. Some physicians have advocated intravenous or retrograde urography to demonstrate the displacement of the kidneys by a mass, but since there is normally a wide range in the position of both kidneys, we do not consider this procedure reliable.

The lesions of the adrenals with which we are concerned are those that cannot be identified without the use of contrast agents. Aortography has been useful in demonstrating retroperitoneal neoplasms, particularly those of the kidney, but the consensus of opinion appears to be that this method is of no value in the diagnosis of small adrenal lesions.

Goodwin (2, 10) has been successful in showing the circulation of the normal adrenal gland (Fig. 1) and, in some cases, small tumors of the adrenal (Fig. 2). He uses a combination of extraperitoneal pneumography and translumbar or, preferably, percutaneous femoral aortography. It is his opinion that aortography is particularly useful for the detection of small or moderate-sized pheochromocytomas which usually are quite vascular. These tumors occur in locations other than the adrenal area and might not be seen with extraperitoneal pneumography alone.

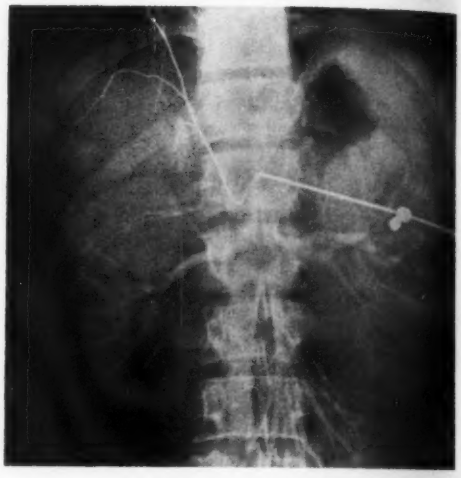


Fig. 1. Translumbar aortogram demonstrating the normal circulation of the right adrenal.

If, as in extraperitoneal pneumography, a gas is introduced into the areolar tissue surrounding the adrenals, the margins of the gland may be distinguished from the surrounding tissues.

Both aortography and extraperitoneal pneumography, like other contrast examinations, entail some risk, but a discussion of this problem is beyond the scope of this paper (6, 7, 9).

NORMAL ADRENALS

Position: The adrenal glands are located cephalad to the kidneys, with the caudal part frequently overlapping the upper ventral surface of the kidney. The adrenal and kidney are enclosed by a loose fascial sheath known as Gerota's fascia (Fig. 3). The kidney is movable to a variable extent, but the adrenal is firmly

[1] From the Department of Radiology, the Department of Surgery-Urology, the Department of Medicine, and the Metabolic Unit for Research in Arthritis and Allied Diseases, University of California School of Medicine, San Francisco, Calif. Presented as part of a Symposium on Contrast Media in the Diagnosis of Retroperitoneal Abnormalities, at the Forty-Second Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2–7, 1956.

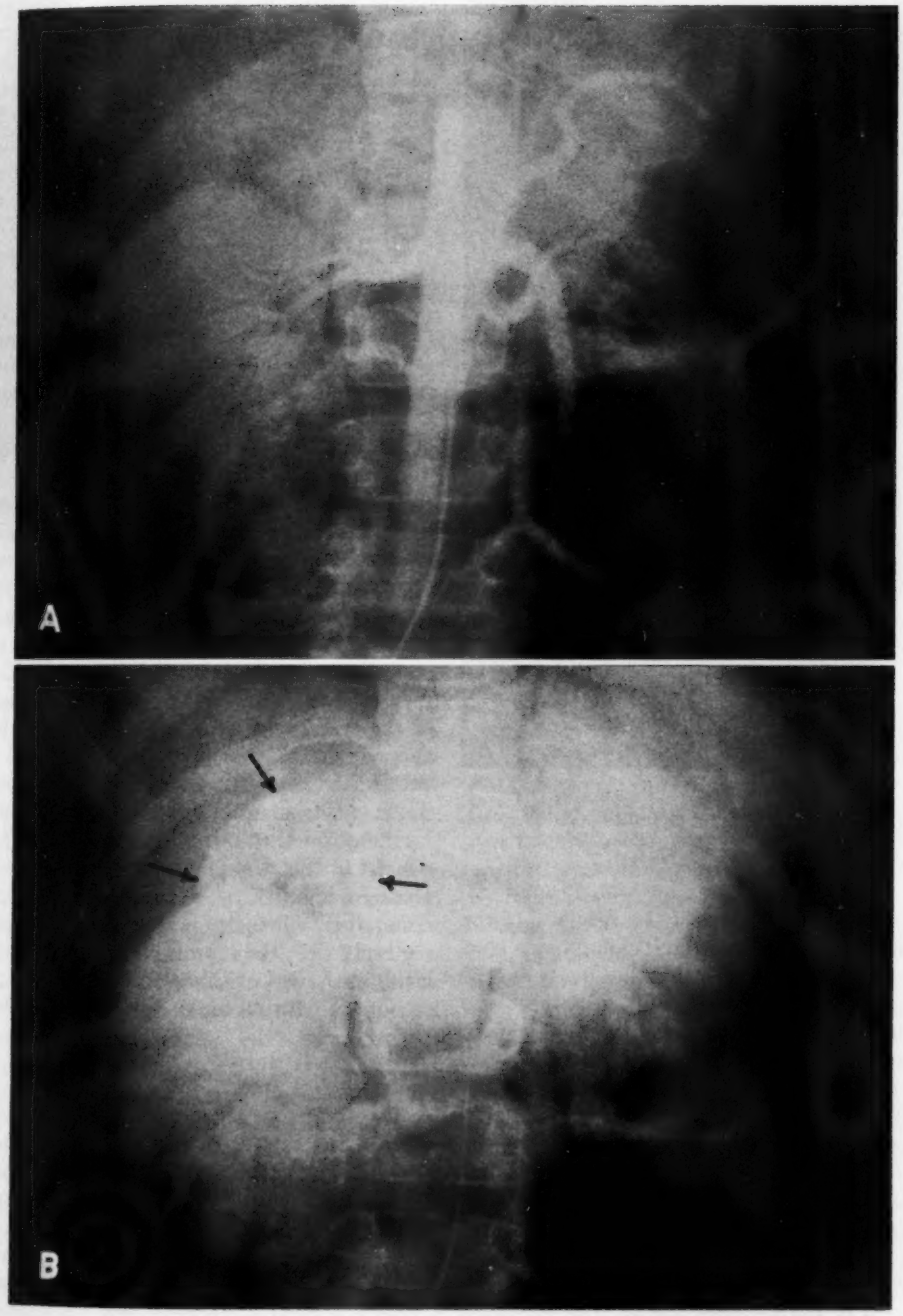


Fig. 2. Percutaneous femoral aortogram. A. The arterial circulation to a pheochromocytoma of the right adrenal. B. The capillary and venous phases of the same injections. (Films of Figs. 1 and 2 kindly provided by Dr. Willard E. Goodwin.)

Fig. 2. Tomogram of the left kidney and adrenal area. Gerota's fascia is the thin membrane surrounding the kidney and adrenal. (From Steinbach and Smith: Arch. Surg. **70:** 161, 1955.)

attached to the apex of the fascia. If the kidney is low in position it will lie at a considerable distance from the base of the adrenal. The presence of gas about the kidney increases its mobility, and it may move for considerable distances and rotate along its vertical axis.

Shape: The right adrenal generally is described as being triangular and the left as being semilunar in shape. The left gland may, however, appear triangular, and both may appear long and slender on the pneumograms.

Size: The adrenals differ considerably in size in normal individuals, the variation being accounted for largely by the cortex, which contributes about 90 per cent of the weight of the gland. In a previous study the cross-sectional area of the adrenals was measured on extraperitoneal pneumograms, with the aid of a compensating planimeter. The average area in a group of patients in whom pneumography was done for evaluation of disease in organs other than the adrenals was 4.2 sq. cm., with a range from 2.0 to 8.7 sq. cm. There was no appreciable difference between the two sides. Some of the adrenal glands may have been enlarged to some extent as a result of the disease process for which the patients were being examined (9). Spann and Heinemann found, in 200 autopsied cases, that the adrenal weight was above average in severe diseases, especially in atheromatosis, nonspecific inflammations, and hepatic and renal diseases (8).

The weight of the normal adrenal gland has been accepted as 5 to 7 gm., but studies of autopsied cases have revealed a wide variation. In an investigation of 200 persons who died from trauma or natural causes, Holmes, Moon and Rinehart (4) reported a range of 3.9 to 23.3 gm., with a mean of 11.6 gm. for the combined weight of the two glands. They also showed that the weight of the adrenal was related to the weight and surface area of the person. Thus, a large individual is likely to have larger adrenals than a small person. The weight of the adrenals in males was greater than in females by approximately 11 per cent; but, when the figures were corrected for body size, the females had slightly more adrenal tissue per kilogram of body weight or square centimeter of body surface than the males.

DISEASES OF THE ADRENALS

The diseases of the adrenals with which we are primarily concerned are hyperplasias of the cortex, cortical adenomas, adenocarcinomas, and tumors of the adrenal medulla or pheochromocytomas.

Overactivity of the adrenal cortex may cause androgenic and anabolic changes (adrenogenital syndrome and virilization) if the androgenic hormones predominate, as reflected in the excretion of urinary

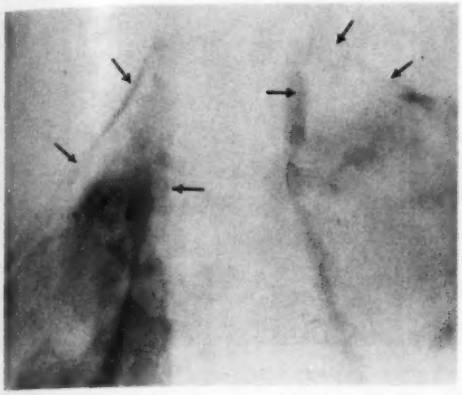


Fig. 4. Adrenal hyperplasia. Both adrenals are enlarged but retain their triangular shape. The indistinct demarcation of the adrenal margins is usual in this disease. (From Steinbach and Smith: Arch. Surg. **70**: 161, 1955.)

Fig. 5. Adrenal cortical adenoma of a child with adrenogenital syndrome. Gerota's fascia surrounds the adrenal mass. (From Steinbach and Smith: Arch. Surg. **70**: 161, 1955.)

17-ketosteroids. On the other hand, the overactivity may result in an excess of hormones having an almost pure catabolic or nitrogen-wasting effect, resulting in the increased excretion of 17-hydroxycorticoids and producing the clinical features of Cushing's syndrome. Most often, the picture is a mixed one, both clinically and as judged by the laboratory findings.

Adrenal Cortical Hyperplasia: In a previous investigation, 10 proved cases of cortical hyperplasia with Cushing's syndrome were studied with extraperitoneal pneumograms. Measurements on the anteroposterior films showed the adrenals of the adults to be considerably larger than in the control group previously described. The average area of the right adrenal was 12.0, and of the left 12.3 sq. cm. (normal average, 4.2 sq. cm.). Although some of the glands were enlarged considerably, they retained their triangular or semilunar shape. The bilateral enlargement helped to differentiate this condition from Cushing's syndrome produced by cortical adenoma or adenocarcinoma, where the adrenal opposite the tumor is atrophic.

On extraperitoneal pneumograms, the adrenals of most patients with cortical hyperplasia were poorly outlined. This is presumably due to an increase in the fatty areolar tissue surrounding the gland, which produces a markedly reticulated irregular shadow (Fig. 4). These examinations were initially reported as being unsatisfactory until it became obvious that few hyperplastic glands were as sharply outlined as the glands in normal lean individuals (9).

Since the foregoing paper was published, and as additional cases have accumulated, a few examples of Cushing's syndrome have been seen in which the size of the adrenals was assessed on the roentgenograms as normal. Also, some adrenals removed surgically from patients with Cushing's syndrome have weighed less than 6 gm., which is considered well within the normal range. Histologically, however, these normal-sized adrenal glands presented evidence of hyperplasia. No statistical correlation between the size of the gland and the degree of excretion has been demonstrated.

A study (3) conducted at this institution on adrenocortical function in 54 obese

Fig. 6. Small left adrenal cortical adenoma in a patient with Cushing's syndrome. The left adrenal tumor cannot be differentiated from adrenal hyperplasia, but the extreme atrophy of the right adrenal indicates the presence of an adenoma. (From Steinbach and Smith: Arch. Surg. **70**: 161, 1955.)

Fig. 7. Medium-sized cortical adenoma on the right side in a patient with Cushing's syndrome. The corners are becoming rounded and the mass is tending to assume the shape of a sphere. The left adrenal is atrophic. (From Steinbach and Smith: Arch. Surg. **70**: 161, 1955.)

women showed a 30 per cent increase in the mean twenty-four-hour excretion of urinary 17-hydroxycorticoids and a slightly decreased mean excretion of 17-ketosteroids as compared with the normal. The elevated urinary excretion of 17-hydroxycorticoids in this group occasionally differed little from that exhibited by patients with Cushing's syndrome. It was found, furthermore, that the elevation of urinary corticoid excretion was related roughly to body weight and closely and directly to body surface area (5). This evidence of increased activity of the adrenal glands in obese patients was consistent with the roentgen impression of enlarged adrenals, as demonstrated on extraperitoneal pneumograms.

These investigations indicate that extraperitoneal pneumography is in most cases a reliable method for estimating the size of the adrenal glands, but that, in the absence of clinical or laboratory evidence of altered secretion, the size of the glands is of no significance; it must be correlated with body weight or surface area. Also, although as a rule the larger glands secrete more hormone, glands of normal size in patients with Cushing's syndrome are occasionally capable of excessive secretion.

Adrenal Cortical Adenoma: Adrenal cortical adenomas may or may not be associated with endocrine disturbances. The nonfunctioning tumors are frequently very large when discovered because of the absence of systemic manifestations. They usually appear as oval or spherical masses, producing a downward displacement and rotation of the kidney. Gerota's fascia can in most cases be identified by retroperitoneal pneumography, particularly on tomograms, and can be seen to enclose the adrenal lesion (Fig. 5). This aids in differentiating these lesions from masses arising in tissues outside of the fascia. The adrenal opposite the nonfunctioning adenoma is of normal size.

The functioning cortical adenomas may produce clinical evidence of Cushing's syndrome due to excessive secretion of 17-hydroxycorticoids, or they may produce the adrenogenital syndrome because of an excess of 17-ketosteroids. A very small adenoma cannot be detected by roentgen methods. In our experience, however, patients presenting clinical evidence of Cushing's syndrome or adrenogenital syndrome due to the presence of a cortical adenoma have all exhibited some adrenal enlargement roentgenographically. In the initial stages the gland may retain its normal contour (Fig. 6). As it enlarges, the sharp angles become rounded, and eventually, with further increase in size, it tends to become more spherical (Fig. 7). The cortical adenomas producing Cushing's

TABLE I: RELIABILITY OF ROENTGENOGRAMS IN CUSHING'S SYNDROME: TWENTY CASES, PROVED SURGICALLY (3).

	Total Cases	Plain Films		Presacral Pneumograms	
		Diagnostic	Error	Diagnostic	Error
Hyperplasia*	14	0	0	13	1
Adenoma	4	0	1	4	0
Carcinoma	2	0	0	1	1

* Normal sized glands may show microscopic evidence of hyperplasia and produce clinical evidence of Cushing's syndrome. Three such cases are included in this category.

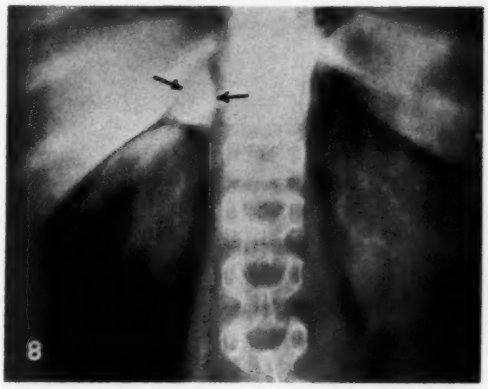


Fig. 8. Small adenocarcinoma of the right adrenal in a young male. The tumor is encapsulated and the gland retains its normal shape. The diagnosis of a unilateral tumor can be made by the presence of atrophy of the contralateral adrenal. It can be assumed that the lesion is malignant, as unilateral cortical tumors in males are almost invariably malignant.

syndrome, or those concomitant with the adrenogenital syndrome in which there is some excess of 17-hydroxycorticoid secretion in addition to the large excess of androgenic hormones, can be differentiated from the nonfunctioning adenomas and bilateral cortical hyperplasia by the demonstration of an atrophic contralateral adrenal, resulting from the inhibitory effect of 17-hydroxycorticoids upon the pituitary.

Adrenal Cortical Adenocarcinoma: Adenocarcinoma, if it remains confined to the gland, may present the same appearance on the roentgenogram as a benign tumor. In most cases, there are excessive production and excretion of 17-hydroxycorticoids with associated atrophy of the contralateral adrenal (Fig. 8). As the lesion enlarges or invades the surrounding tissues, it may compress or invade the periadrenal areolar tissue and prevent the passage of gas into the adrenal area.

In all cases of suspected Cushing's syndrome it is imperative that both adrenals be demonstrated. A small adenoma or carcinoma may present the same roentgenographic appearance as a hyperplastic gland. However, the contralateral gland in patients with adenoma or carcinoma will be atrophic, whereas both of the hyperplastic adrenals will be of approximately the same size.

In a study of 20 surgically proved cases of Cushing's syndrome—including 14 cases of bilateral hyperplasia, 4 cases of adenoma, and 2 cases of carcinoma—the extraperitoneal pneumograms were interpreted correctly in 18 (3). One error was made as a result of too much gas being present, so that bilateral hyperplasia was interpreted as unilateral adenoma. The other error was in a case of carcinoma in which the adrenal glands were not outlined. These results are presented in Table I. Since there has not been a complete correlation between the weight of the removed glands and the hormone excretion, 3 cases of hyperplasia with both adrenals interpreted as of normal size are included with those cases having large glands, for purposes of differentiating them from cases with unilateral tumors.

Some investigators state that adrenal lesions are usually demonstrated on plain roentgenograms and that air contrast examinations are unnecessary (1). Though plain films and urograms were obtained in all of the 20 cases cited above and tomograms were made in some, none contributed to the diagnosis. It is appreciated that large or moderately large tumors can sometimes be seen on plain films or may be suspected because of displacement of the adjacent kidney, but in this series none of the lesions was of sufficient size to be identified without the aid of air contrast.

Fig. 9. Small pheochromocytoma of the left adrenal

Fig. 10. Bilateral pheochromocytomas. (From Steinbach and Smith: Arch. Surg. **70:** 161, 1955.)

Pheochromocytoma: Pheochromocytomas may arise in the adrenal medulla or elsewhere in the sympathetic nervous system. When present outside of the adrenal medulla, they have been referred to as paragangliomas, a term also used to describe the adrenal tumors. In contrast to cortical tumors, which almost invariably arise in the adrenal glands, pheochromocytomas have been found in the abdomen, in paraganglionic tissue near the bifurcation of the iliac vessels, and in other extra-abdominal sites. Approximately 20 per cent of patients with this disease have more than one tumor.

The roentgen shadow cast by a pheochromocytoma does not differ significantly from that of an adrenal adenoma or an encapsulated carcinoma (Figs. 9 and 10). It appears as a unilateral or bilateral spherical mass, generally replacing the adrenal but occasionally lying outside of Gerota's fascia. The lesion can be differentiated easily by the clinical and laboratory findings.

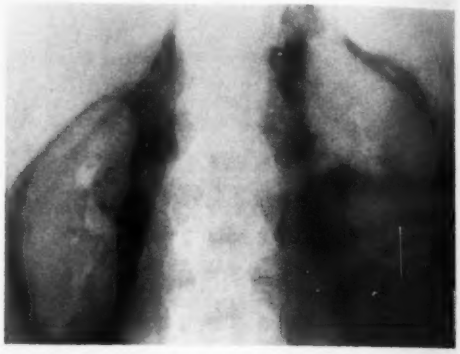


Fig. 11. Both adrenals are smaller than normal. A virilizing adrenal rest tumor was removed from the pelvis. (From Steinbach and Smith: Arch. Surg. **70:** 161, 1955.)

Bilateral Small Adrenals: Under certain circumstances, bilateral small atrophic adrenals may indicate the presence of an extra-adrenal tumor, secreting an excess of adrenal cortical steroids. A female patient with symptoms and signs of virilism, marked elevation of 17-ketosteroid urine excretion, and some increase in 17-hydroxycorticoids, was suspected of having an adrenal tumor. The pneumograms revealed very small adrenals, measuring 0.3 sq. cm. on the right side and 1.1 sq. cm. on the left. Exploration showed the left adrenal to be atrophic. Subsequent pelvic surgery revealed an adrenal rest tumor, called an ovoblastoma, of the left ovary (Fig. 11).

SUMMARY

Plain roentgenograms and intravenous urograms are of little value in the diagnosis of hyperplasia or small tumors of the adrenal glands.

Aortography is useful in identifying vascular lesions of the adrenals such as pheochromocytomas.

Extraperitoneal pneumography with tomography is the most useful roentgen procedure for identification of cortical hyperplasia, unilateral benign or malignant tumors, and cortical atrophy of the adrenals.

The hyperplastic glands are usually bilaterally enlarged. Occasionally the glands, though presenting histologic evidence of hyperplasia and clinical and laboratory evidence of Cushing's syndrome, will be of normal size. The size of normal adrenal glands and their rate of excretion of corticoids vary directly with the body weight or surface area of the patient. Functioning cortical adenomas and adenocarcinomas in patients with Cushing's syndrome are usually accompanied by atrophy of the contralateral adrenal. In cases of cortical adenoma or adenocarcinoma with adrenogenital syndrome, the opposite gland is of normal size when there is no associated excess of 17-hydroxycorticoid.

Pheochromocytomas of the adrenal appear similar to adrenal cortical tumors.

Bilaterally small adrenals may indicate the presence of a functioning adrenal cortical tumor in an extra-adrenal site.

REFERENCES

1. COPE, O., AND RAKER, J. W.: Cushing's Disease. The Surgical Experience in the Care of 46 Cases. New England J. Med. **253:** 119–127, July 28, 1955; 165–172, Aug. 4, 1955.
2. GOODWIN, W. E.: Personal communication.
3. HINMAN, F., JR., STEINBACH, H. L., AND FORSHAM, P. H.: Preoperative Differentiation Between Hyperplasia and Tumor in Cushing's Syndrome. Tr. Am. A. Genito-Urin. Surgeons **48:** 97–106, 1956.
4. HOLMES, R. O., MOON, H. D., AND RINEHART, J. F.: A Morphologic Study of the Adrenal Glands with Correlations of Body Size and Heart Size. Am. J. Path. **27:** 724–726, July-August 1951.
5. POISNICK, J., DI RAIMONDO, V. C., AND FORSHAM, P. H.: Adrenal Cortical Function in Obesity. To be published.
6. RANSOM, C. L., LANDES, R. R., AND MCLELLAND, R.: Air Embolism Following Retroperitoneal Pneumography: A Nation-Wide Survey. J. Urol. **76:** 664–670, November 1956.
7. SALTZ, N. J., LUTTWAK, E. M., SCHWARTZ, A., AND GOLDBERG, G. M.: Danger of Aortography in the Localization of Pheochromocytoma. Ann. Surg. **144:** 118–123, July 1956.
8. SPANN, W., AND HEINEMANN, W.: Gewicht und Lipoidgehalt der Nebenniere in Abhängigkeit von der Todesursache. Deutsche Ztschr. f. d. ges. gerichtl. Med. **44:** 77–97, 1955.
9. STEINBACH, H. L., AND SMITH, D. R.: Extraperitoneal Pneumography in Diagnosis of Retroperitoneal Tumors. Arch. Surg. **70:** 161–172, February 1955.
10. WALTER, R. C., AND GOODWIN, W. E.: Aortography and Retroperitoneal Oxygen in Urologic Diagnosis: A Comparison of Translumbar and Percutaneous Femoral Methods of Aortography. J. Urol. **70:** 526–537, September 1953.

University of California Medical Center
San Francisco 22, Calif.

SUMMARIO IN INTERLINGUA

Le Diagnose De Neoplasmas Adrenál Per Medio De Substantias A Contrasto

Simple roentgenogrammas e urogrammas intravenose es de pauc valor in le diagnose de hyperplasia o de micre tumores del glandulas adrenal.

Aortographia es utile in le identification de lesiones vascular del adrenales, *i.e.* per exemplo de pheochromocytomas.

Pneumographia extraperitoneal con tomographia es le plus utile manovra roentgenographic in le identification de hyperplasia cortical, de unilateral tumores benigne o maligne, e de atrophia cortical del adrenales.

Le glandulas hyperplastic exhibi usualmente allargamento bilateral. In certe casos le glandulas retene lor dimensiones normal in despecto del facto que illos exhibi provas histologic de hyperplasia e signos clinic e laboratorial de syndrome de Cushing. Le dimensiones de normal glandulas adrenal e le mesura de lor excretion de corticoides varia directemente con le peso o le superficie corporee del patiente. Functionante adenomas e adenocarcinomas cortical in patientes con syndrome de Cushing es usualmente accompaniate de atrophia del adrenal contralateral. In le majoritate del casos de adenoma o adenocarcinoma cortical con syndrome adrenogenite, le glandula contralateral exhibi dimensiones normal. Pheochromocytomas del adrenales es de apparentia simile a tumores adreno-cortical. Le presentia bilateral de micre adrenales indica possibilemente le existentia de un functionante tumor adreno-cortical in un sito extra-adrenal.

Use of Contrast Media in the Recognition of Hypertension of Renal Origin[1]

GEORGE T. WOHL, M.D.[2]

THERE ARE TWO major types of hypertension: primary hypertension, in which the etiology is still indeterminate, and the much rarer secondary hypertension, the result of renal, endocrine, neurologic, or cardiovascular disturbances. In this latter group the etiology may be clinically demonstrable even though the details of the pressor mechanism involved are still incompletely understood. We are principally concerned here with the problem of renal hypertension and its evaluation by roentgenologic methods, with particular reference to the use of retroperitoneal contrast studies.

Renal hypertension may be divided into two types—first, that developing secondary to primary renal disease and, secondly, the much less common type developing as a result of renal circulatory disturbance. A variety of primary kidney diseases may be accompanied by hypertension:

I. Infections
   (*a*) Glomerulonephritis
   (*b*) Pyonephrosis
   (*c*) Tuberculosis
II. Obstructive Uropathy
   (*a*) Renal Calculus
   (*b*) Hydronephrosis
III. Neoplasia
   (*a*) Solitary Cysts
   (*b*) Malignant Neoplasm
IV. Congenital Abnormalities
   (*a*) Polycystic Disease
   (*b*) Hypoplasia

By far the most common type of hypertension in the first group is that developing as a result of glomerulonephritis. Pyonephrosis, tuberculosis, obstructive uropathy, neoplasia, and congenital abnormalities all have been responsible for hypertension in well documented cases. Occasionally when the disease is unilateral, surgical extirpation of the involved kidney may result in dramatic improvement of the patient.

Fig. 1. Intravenous urogram. The right kidney is small but excretion of the contrast medium is observed. (From Pastor, Myerson, Wohl, and Rouse: Ann. Int. Med. **42**: 1122, 1955.)

Since the classic experimental demonstration by Goldblatt in 1934, in which he produced definite hypertension secondary to interference with renal circulation in dogs, at least 45 similar cases have been reported in man. It is now generally accepted that interference with the circulation of all or a portion of a kidney may definitely produce hypertension.

Two main forms of interference have been described. A very rare form is that resulting from pressure on the major renal artery by extrinsic sources. Aortic aneurysms and retroperitoneal tumors are the prime offenders.

[1] From Veterans Administration Hospital, Philadelphia, Penna. Presented as part of a Symposium on Contrast Media in the Diagnosis of Retroperitoneal Abnormalities, at the Forty-Second Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2–7, 1956.

[2] Chief, Radiological Service, Veterans Administration Hospital, Philadelphia, Penna.

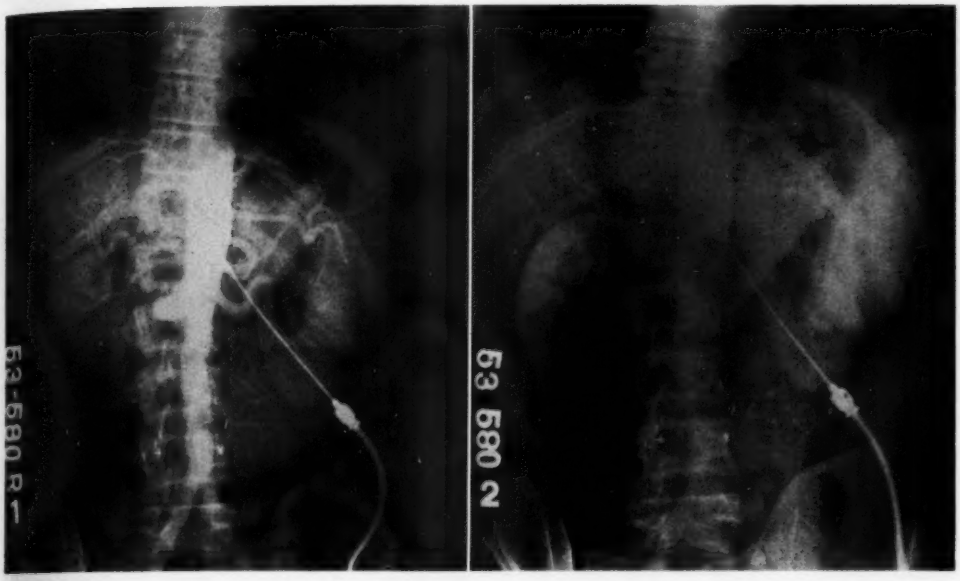


Fig. 2 (left). Percutaneous lumbar aortogram showing accessory right renal artery and contrast-filled aneurysm.
Fig. 3 (right). Percutaneous lumbar aortogram obtained thirty seconds after injection. Note nephrographic effect in cephalad two-thirds of right kidney. Absence of medium in lower third. (Figs. 2 and 3 from Pastor, Myerson, Wohl, and Rouse: Ann. Int. Med. **42**: 1122, 1955.)

Intrinsic disturbance of the renal circulation producing secondary hypertension is somewhat less rare than interference as a result of pressure on the major vessels but is still quite unusual. The common causes of interference with circulation resulting in renal hypertension are (*a*) embolism, (*b*) thrombosis, (*c*) developmental defects (fibrous intimal proliferation), (*d*) arteriosclerotic plaques, (*e*) aneurysm, and (*f*) syphilitic arteritis. This type of renal hypertension is well illustrated by a case seen in our institution.

CASE REPORT

A 36-year-old white male was admitted to the Veterans Administration Hospital, Philadelphia, in February 1953, because of intermittent right flank pain of one and a half years duration, which had become worse ten days prior to admission. The blood pressure was 210/126 mm. of mercury. There was a Grade II hypertensive retinopathy, with attenuation and tortuosity of the arterioles and arteriovenous "nicking" but no hemorrhages or exudates. The heart was not enlarged.

A survey film of the abdomen demonstrated a small right kidney. On intravenous urographic study (Fig. 1), however, there was excellent concentration of the medium in both kidneys in the usual time interval, five minutes after injection. The pelvicalyceal system appeared normal roentgenographically.

Differential studies showed some impairment of renal function on the right, but the total function was excellent. An aortogram was obtained, with visualization of one of the collateral right renal arteries but no demonstration of the main right renal artery. In view of the good renal function bilaterally, the house staff did not consider nephrectomy indicated.

The patient was readmitted some six months later because of continued right-sided abdominal pain. His blood pressure was still elevated, and the medical evaluation remained unchanged. The lumbar aortogram was repeated, and this time a number of interesting findings were demonstrated (Figs. 2 and 3). The lower third of the right kidney showed a poor nephrographic effect, but the upper two-thirds appeared to be supplied with blood from an accessory renal artery. At the site of origin of the main renal artery was a rounded density which persisted after the contrast medium had disappeared from the rest of the abdominal circulation. This was interpreted as a saccular aneurysm of the right renal artery, with occlusion distal to this sac. The left renal artery was normal. The left kidney was normally vascularized.

At operation a ruptured right renal aneurysm with a false aneurysmal sac filled with laminated clot

Fig. 4. Operative specimen showing aneurysm and kidney.

was exposed (Fig. 4). Right nephrectomy and repair of the aorta at the site of origin of the renal artery was accomplished. The blood pressure returned to normal and has remained at a normal level in the ensuing three-year period. Pathologic examination of the kidney confirmed the presence of a large false aneurysm filled with laminated clots. Microscopic study revealed atrophy and degenerative changes, with predominantly tubular involvement.

DISCUSSION

A number of interesting points are illustrated by this case. Many patients have an accessory renal arterial circulation which allows adequate function of a segment of a kidney even though there is occlusion of the main renal artery. A segment supplied by an accessory artery may function with sufficient adequacy to excrete contrast material normally into the pelvicalyceal system and afford the radiologist a normal urographic demonstration. Cases have been reported in which the size of the kidney has not been significantly affected even though a major arterial obstruction has occurred. Thus, normal renal function and a normal intravenous urogram do not necessarily exclude interference with the circulation.

Many authors have pointed out further that an important clinical characteristic frequently observed in these patients is a long history of back pain not explained on usual grounds. This syndrome of prolonged back pain in progressive hypertension is in itself an indication for a complete roentgen evaluation.

In the study of patients with suspected renal hypertension the scout film remains of first importance. In it one may obtain the first intimation of renal disease. Large polycystic or hydronephrotic kidneys may be observed. Ureteral calculi may be demonstrated. Cases have even been reported in which the diagnosis of renal artery aneurysm has been made on the basis of the typical ring calcification in the scout film.

The most valuable and most commonly used retroperitoneal contrast study is the routine intravenous urographic examination and its complement, retrograde pyelography.

While these routine studies may often furnish adequate information, there is a group of patients in whom aortography is definitely indicated for delineation of the primary circulatory disturbance. These are patients in whom one has obtained a history of back pain of rather recent origin, serious hypertension, and no family history of hypertension. The kidney may be small, as it often is, or it may be normal in size. Occasionally one will recognize the diminished size only by comparison with an earlier intravenous urogram taken before the development of the renal abnormality. The demonstration of a nonfunctioning small kidney may in itself be taken as presumptive evidence of a renal origin of hypertension and, if the changes in the contralateral kidney are not too far advanced, surgical extirpation may relieve or cure the hypertensive state.

Lumbar aortography by the percutaneous route is a relatively simple technical procedure but is attended by occasional serious accidents, as is pointed out by others contributing to this symposium. It should be recognized, however, that aortography affords us a definite modality

for the preoperative diagnosis of hypertension of renal origin.

Retroperitoneal contrast study with a gaseous medium has occasionally been found of use in demonstrating the absence of a kidney or showing a small, nonfunctioning organ. It has found little practical application in the study of renal hypertension.

VA Hospital
Philadelphia 4, Penna.

REFERENCES

ADAMS, L. J.: Hypertension and Unilateral Kidney Disease: Late Results of Nephrectomy in 7 Patients. Canad. M. A. J. **73**: 800–804, Nov. 15, 1955.

FINDLEY, T.: Two Kinds of Renal Hypertension. Am. J. M. Sc. **231**: 121–124, February 1956.

HANDLER, F. P.: Clinical and Pathologic Significance of Atheromatous Embolization, with Emphasis on an Etiology of Renal Hypertension. Am. J. Med. **20**: 366–373, March 1956.

HOWARD, J. E., BERTHRONG, M., GOULD, D. M., AND YENDT, E. R.: Hypertension Resulting from Unilateral Vascular Disease and Its Relief by Nephrectomy. Bull. Johns Hopkins Hosp. **94**: 51–85, February 1954.

KOBAYASHI, O., AND SAKAGUCHI, S.: Unilateral Renal Hypertension in a Girl Cured by Nephrectomy. J. Pediat. **48**: 57–62, January 1956.

LAFORET, E. G.: Malignant Hypertension Associated with Unilateral Renal Artery Occlusion: 3 Cases. Ann. Int. Med. **38**: 667–688, April 1953.

PALMER, R. S.: Essential Hypertension; Selected Review and Commentary. New England J. Med. **252**: 940–947, June 2, 1955.

POUTASSE, E. F.: Occlusion of a Renal Artery as a Cause of Hypertension. Circulation **13**: 37–48, January 1956.

POUTASSE, E. F., AND DUSTAN, H.: Urologic Causes of Hypertension. I. Hypertension Due to Renal Artery Lesions. Cleveland Clin. Quart. **23**: 3–15, January 1956.

POUTASSE, E. F., HUMPHRIES, A. W., MCCORMACK, L. J., AND CORCORAN, A. C.: Bilateral Stenosis of Renal Arteries and Hypertension; Treatment by Arterial Homografts. J.A.M.A. **161**: 419–423, June 2, 1956.

SUMMARIO IN INTERLINGUA

Le Uso De Substantias De Contrasto In Le Recognition De Hypertension De Origine Renal

Hypertension renal pote occurrer secundari a un primari morbo renal—glomerulonephritis, uropathia obstructive, neoplasia, o anormalitates congenite—o illo pote esser le resultato de un disturbation del circulation renal. Le causas commun de disturbate circulation renal es embolismo, thrombose, defectos disveloppamental, placas arteriosclerotic, aneurysma, e arteritis syphilitic.

Roentgenogrammas exploratori es del prime importantia in le studio de patientes con hypertension renal. Le plus utile e le plus communmente empleate studio retroperitoneal a contrasto es le routinari examine urographic intravenose e su complemento, pyelographia retrograde. In certe casos—con un historia recente de dolores dorsal e con serie grados de hypertension in le absentia de un historia familial de alte pression de sanguine—aortographia lumbar es possibilemente indicate. Es reportate un caso in que aortographia lumbar suggereva le presentia de un aneurysma del arteria dextero-renal con occlusion distal al sacco. Le operation revelava un rupturate aneurysma renal con un false sacco aneurysmal que contineva un coagulo laminate. Le reparation del aorta al sito de origine del arteria renal esseva sequite per un retorno del pression de sanguine a nivellos normal.

Aortic Thrombosis as a Cause of Hypertension: An Arteriographic Study[1]

GEORGE M. WYATT, M.D., and BENJAMIN FELSON, M.D.

GOLDBLATT AND his co-workers (1) discovered that constriction of one renal artery caused transient systemic hypertension in dogs and prolonged hypertension in other animals. *Complete* occlution of the renal artery did not produce this effect. Constriction of both renal arteries resulted in persistent hypertension, as did constriction of one renal artery after removal of the opposite kidney. It was also shown that hypertension could be produced by constricting the aorta proximal to the renal arteries but not by compression applied distal to these vessels. Excision of the ischemic kidney following unilateral constriction resulted in disappearance of the hypertension.

Since these classical experiments, many cases of hypertension associated with constriction of a main renal artery have been reported. Among these a variety of arterial lesions has been found; all appear to have in common *partial* interruption of the blood flow to a kidney. These cases represent the human counterpart of Goldblatt's animal experiments.

Yuile (2) classified constriction of the renal artery as of intrinsic and extrinsic origin. The intrinsic causes include embolism (3–7), thrombosis (8–12), developmental defects (13), aneurysm (14, 15), arteriosclerotic plaques (16), and syphilitic arteritis (17). Extrinsic causes are compression of the renal artery by aortic aneurysm (18), retroperitoneal tumor (19), hydatid cyst (20), organizing hematoma (21), intrarenal tumor (22), and kinking or torsion (23, 24).

While the value of abdominal arteriography for the detection of these conditions has frequently been mentioned, relatively few arteriograms have been made for this purpose. In fact, there has been little effort to assess the status of the renal arteries by this means in any group of patients with hypertension, whatever the cause. In earlier reports on abdominal arteriography from the Cincinnati General Hospital (25, 26) only one of the 75 patients with hypertension showed constriction of a main renal artery. Because of this experience, we believe that arteriography has little value as a routine measure in the clinical investigation of the hypertensive patient.

Moderately elevated blood pressure is not uncommon among patients suffering from thrombosis of the abdominal aorta. The explanation for this is obscure, but it is apparent from our own arteriograms and those appearing in the literature that it does not usually originate from renal artery constriction. However, upward extension of the thrombus to involve a renal artery does occur in this disease and may produce severe hypertension. To our knowledge, the demonstration of this combination of circumstances has not been previously recorded.

The present report deals with 3 such cases. In each, abdominal arteriograms were available before and after the development of hypertension and vividly portrayed the changes presumably responsible for the blood pressure elevation.

REPORT OF CASES

CASE I: A. F., a 35-year-old white female, first seen in September 1948, complained of intermittent claudication in the lower extremities of four months duration. The blood pressure was 110/70. Aortic pulsations were palpable in the upper abdomen but absent in the lower, and the femoral pulses were impalpable bilaterally. A clinical diagnosis of thrombosis of the lower abdominal aorta was made. A

[1] From the Department of Radiology, University of Cincinnati College of Medicine and Cincinnati General Hospital, Cincinnati, Ohio. Presented as part of a Symposium on Contrast Media in the Diagnosis of Retroperitoneal Abnormalities, at the Forty-Second Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2–7, 1956.

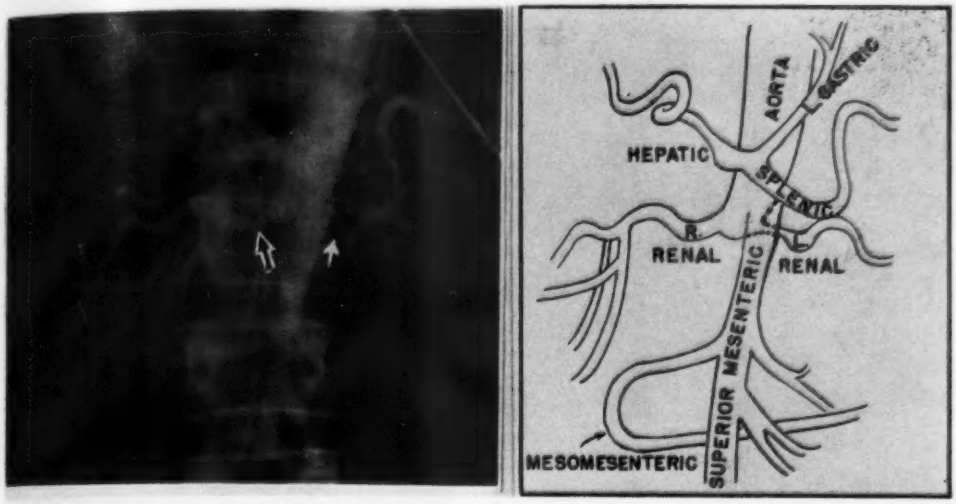


Fig. 1. Case I. Translumbar arteriogram, March 1952. The aorta is occluded just distal to the renal arteries (arrows). The right renal artery is normal; the orifice of the left is partly occluded and the vessel is reduced in caliber and density. The left kidney is considerably smaller than the right. Blood pressure 220/120.

translumbar arteriogram was attempted but was unsuccessful. At operation (exploration of the aorta), the diagnosis was confirmed. The upper margin of the thrombus lay well below the level of the renal arteries. Bilateral lumbar sympathectomy was performed.

Postoperatively there was considerable improvement in the leg symptoms. During the following year, 1949, the patient was twice admitted to the hospital, once for repair of an incisional hernia and once for thrombophlebitis. On each occasion her blood pressure was recorded as normal. She remained relatively well until October 1951, when severe headaches and moderate blurring of vision appeared. Her blood pressure was found to be 226/120. Funduscopic examination revealed Grade II hypertensive retinopathy.

The patient's condition gradually deteriorated over the next four months. In March 1952 an intravenous pyelogram revealed a normally functioning right kidney and impaired renal function on the left. The left kidney was distinctly smaller than on earlier films. Retrograde pyelography showed normal pelvic and calyceal architecture bilaterally. From these studies, partial obliteration of the left renal artery by the aortic clot was suspected, and an abdominal arteriogram was obtained (Fig. 1). This showed the aorta to be completely occluded immediately distal to the renal arteries. The right renal artery was normal, but the orifice of the left was partially occluded. This artery and its branches appeared less opaque and slightly smaller than the right.

A left nephrectomy was performed. The origin of the renal artery was not exposed at operation.

Fig. 2. Case I. April 1954. Slight proximal extension of the thrombus, now causing constriction of the right renal orifice (arrow). The hepatic artery partially obscures the site of aortic occlusion. Left nephrectomy in 1952 was followed by normal blood pressure for two years, but the hypertension subsequently recurred.

The kidney was quite small, weighing only 53 gm. Microscopically, widespread atrophy with obliteration of glomeruli, hyalinization of connective tissue, and perivascular fibrosis were demonstrated. There was no evidence of renal infarction.

Fig. 3. Case II. August 1954. Occlusion of the aorta (black arrow) just distal to the right renal artery. Both renal arteries appear normal (white arrows). Blood pressure 140/70.

The blood pressure fell to normal levels during the first postoperative week and remained normal for approximately two years. The retinal lesions also improved. In April 1954, severe headaches developed, and evidence of congestive heart failure. The blood pressure again was found to be greatly elevated (220/115) and the retinal changes had progressed. An intravenous pyelogram showed the right kidney to be normal in size and function. Another arteriogram (Fig. 2) showed further extension of the aortic thrombus, which now constricted the remaining (right) renal artery orifice. The size and density of the renal artery and its branches had decreased slightly.

Although the hypertension and congestive failure were partially controlled by medication, death ensued approximately one year later from cardiac decompensation. Permission for postmortem examination was refused.

Summary: This patient had thrombotic occlusion of the aorta with gradual propagation of the clot proximally, shown by arteriography. Partial obstruction of the left renal artery produced severe hypertension, which was completely relieved by left nephrectomy. Subsequently, partial occlusion of the right renal artery orifice resulted in recurrence of the hypertension and a fatal termination.

CASE II (reported through the courtesy of Dr. James A. Helmsworth): C. U., a 45-year-old white male, was first seen in January 1954, because of rheumatic heart disease which dated from childhood. Two years earlier he had been hospitalized in another city for an episode of acute vascular insufficiency of the lower extremities. Since that time he had suffered from intermittent claudication. There was no history of impotence.

Physical examination revealed a blood pressure of 140/70, the cardiac murmur of mitral stenosis, auricular fibrillation, and evidence of minimal congestive failure. Neither femoral pulse was palpable. The left atrium was enlarged roentgenologically. Angiocardiography revealed delay in emptying of the large left atrium, which contained a filling defect believed to represent a mural thrombus.

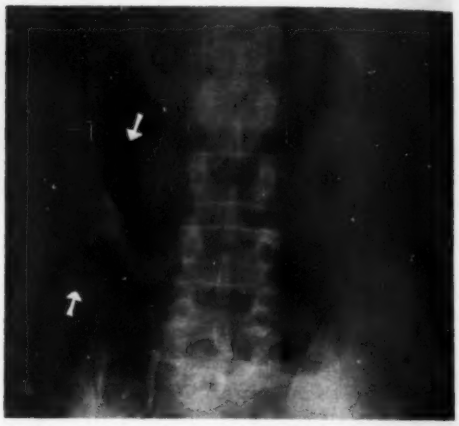


Fig. 4. Case II. Right retrograde pyelogram, April 1955. The internal architecture of the kidney is normal despite its decrease in size. Intravenous pyelography showed a nonfunctioning right kidney. Blood pressure 200/100.

Since it was felt that the cardiac condition was the more urgent problem, commissurotomy of the stenotic mitral valve was performed. A left atrial thrombus was encountered. The operation resulted in considerable improvement in cardiac efficiency.

The patient was readmitted in August 1954 for study of the peripheral vascular disease. The blood pressure was normal. Intravenous pyelography revealed normal excretory systems bilaterally. A translumbar arteriogram demonstrated occlusion of the aorta just distal to the level of the right renal artery. The left renal artery arose from the aorta about 8 cm. above the right (Fig. 3). At operation, the distal end of the thrombotic process was found in the external iliac arteries, precluding excision and grafting. Bilateral lumbar sympathectomy was performed. The leg pain improved moderately.

In April 1955, congestive heart failure developed and the patient complained of headaches and dizziness. The blood pressure was now found to be 200/100. The ocular fundi revealed hypertensive retinopathy. A film of the abdomen showed the right kidney to be about half its original size. Intravenous pyelography revealed a normal left kidney but absence of function on the right. A right retrograde pyelogram showed a small but otherwise

essentially normal renal excretory system (Fig. 4). A small amount of urine of very low specific gravity was obtained through the ureteral catheter.

Serial arteriography demonstrated that the aortic occlusion now extended to a level just distal to the *left* renal artery, which appeared normal. The right renal artery was not seen on the early films (Fig. 5). However, on films made two to four seconds after the injection of contrast medium was completed, the right renal artery could be identified as a faintly opacified vessel with few branches (Fig. 6). Its caliber had decreased by more than 50 per cent since the earlier study. The route of filling of this vessel could not be traced arteriographically.

In May 1955, a right nephrectomy was performed. The kidney was small, weighing 95 gm., and showed localized areas of hemorrhage and infarction. Microscopically, arterio- and arteriolosclerosis were also seen. The blood pressure returned to normal within twenty-four hours and has remained normal for approximately eighteen months. The retinal findings improved.

Summary: This patient had rheumatic heart disease, and occlusion of the aorta developed probably from an embolus arising in the left atrium. Abdominal arteriography demonstrated the aortic lesion. Later severe hypertension occurred. Serial arteriograms revealed proximal extension of the thrombus, which now occluded the right renal artery at its orifice. Delayed filling of a diminutive right renal artery, presumably *via* collaterals, was seen. Following right nephrectomy the blood pressure became normal.

CASE III (reported through the courtesy of Dr. James A. Helmsworth): G. C., a 35-year-old white male, was first admitted in May 1955, with a four-year complaint of intermittent claudication in the legs. There was no history of impotence. Two weeks prior to admission, myocardial infarction occurred, for which the patient was hospitalized elsewhere. The blood pressure was 150/90. Physical examination was negative except for absence of the femoral pulses bilaterally. Electrocardiograms revealed evidence of a posterior myocardial infarction of recent origin. A translumbar arteriogram, June 1955, after the patient had recovered from his heart attack, demonstrated occlusion of the aorta just distal to the renal arteries, which were of normal appearance (Fig. 7).

Six months later operation on the abdominal aorta was performed. The thrombus was found to have extended as a mound-shaped mass above the level of the renal arteries but did not obstruct their orifices. The aorta was divided distal to the renal arteries, a Pott's clamp was placed across the aorta

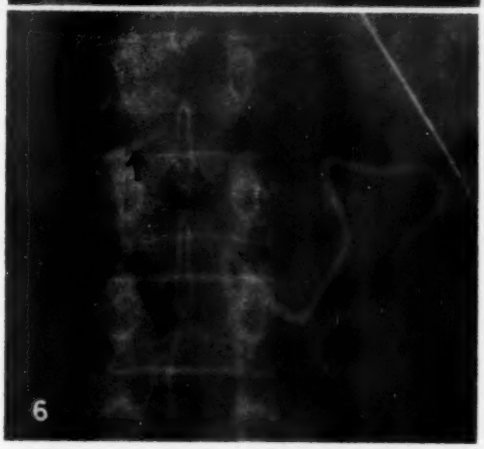


Fig. 5. Case II. April 1955. The aortic occlusion (black arrow) now extends to the left renal artery (white arrows), which appears normal. The right renal artery is not demonstrable (compare with Fig. 3).

Fig. 6. Case II. Film obtained two and a half seconds after Fig. 5. A diminutive right renal artery is now visualized (arrow). The manner of filling of this vessel could not be ascertained.

proximal to the renal vessels, and a longitudinal aortic incision was made just distal to the clamp. The thrombus was pushed downward through this incision and extracted from the infrarenal opening, which was then clamped. The longitudinal incision was repaired and the proximal clamp removed, the renal circulation having been curtailed for only a few minutes. Inferiorly the thrombus was found to extend well into both iliac arteries. The region of

Fig. 7. Case III. June 1955. Occlusion of the aorta (black arrow) just distal to the normal renal arteries (white arrows). Blood pressure 145/85.

thrombosis was resected and replaced with a bifurcation homograft.

Postoperatively there was return of good femoral pulsations. The patient did well for two weeks, when severe headaches developed. The blood pressure was 210/100, and the ocular fundi revealed progressive changes of severe hypertension. Intravenous pyelograms showed a normal left excretory system but absence of function on the right.

The abdominal arteriogram was repeated (Fig. 8). On the initial films a filling defect was seen in the aorta at the site of the right renal artery orifice. The left renal artery appeared normal, but the right was not visualized. The aorta was widely patent, showing only slight constriction at the anastomotic sites. As in Case II, later films in the series revealed the right renal artery. It was slightly smaller and considerably less opaque than previously, and its visible branches were much fewer in number (Fig. 9).

Right nephrectomy was performed. The kidney weighed 130 gm. and appeared grossly and microscopically normal. Following operation, the blood pressure fell within five days to 140/90 and the retinopathy rapidly improved. The blood pressure has remained at this level for eight months.

Summary: This young man had thrombosis of the abdominal aorta confirmed by translumbar arteriography. Shortly after excision and grafting, severe hypertension developed. At this time the arteriogram revealed a small thrombus in the aorta adjacent to and apparently partially occluding the right renal artery. Right nephrectomy relieved the hypertension.

DISCUSSION

In all three cases in the present series

Fig. 8. Case III. August 1955, two weeks after the aorta was resected and grafted. A small clot is seen in the aorta (arrow) at the site of the right renal artery, which is not demonstrable. Blood pressure 210/100.

severe hypertension appeared after encroachment upon one renal artery by the aortic thrombus and was relieved by removal of the affected kidney. In Case I recurrence of the hypertension signaled constriction of the renal artery to the remaining kidney. In none of the cases was significant hypertension present during the period when the occlusion was confined to the aorta distal to the renal arteries. Thus, the findings in these cases closely parallel those of Goldblatt's experiments.

Moderate hypertension is not unusual in abdominal aortic thrombosis even when the thrombus does not extend to the renal arteries. Nevertheless, our findings strongly suggest that *severe* hypertension, particularly if it first appears during the course of the disease, indicates involvement of the orifice of one of the renal arteries. Nephrectomy in such cases may be lifesaving. In 12 personally observed cases of aortic occlusion verified arteriographically

we have encountered no instance of severe hypertension without renal artery involvement. Conversely, we have not seen renal orifice constriction without hypertension in this disease, although in arteriograms made for other conditions we have encountered such narrowing unaccompanied by increased blood pressure.

In each of the present cases the rather sudden appearance of severe hypertension was the clue which led to the discovery of the renal artery constriction. Although, as stated earlier, we do not believe arteriography should be performed *routinely* in the study of the hypertensive patient, our experience with these cases suggests that the procedure may be indicated in any patient with hypertension of recent origin and relatively rapid progression.

In some instances arteriography is not essential for the diagnosis of aortic thrombosis or even for the demonstration of renal artery encroachment in this disease. The symptoms and signs described by Leriche (27) are now well known and generally reliable. Severe arteriosclerosis, however, involving the iliac or femoral arteries bilaterally—not a rare distribution—may present identical clinical findings, so that arteriography is necessary both to confirm the diagnosis and to guide the surgeon in the operative approach.

If intravenous pyelography reveals marked impairment or absence of function in a kidney with normal pelvis and calyces as shown by retrograde pyelography, renal ischemia or infarction may be postulated. The same inference can be made if a kidney shows rapid shrinkage in size. Although these signs are ordinarily reliable when present, their absence does not preclude a lesion constricting the renal artery. In Case I, at the time of the second episode of hypertension, the excretory system of the remaining kidney was visualized normally on intravenous pyelograms despite constriction of its artery. It should also be pointed out that an aortic thrombosis might, theoretically, completely occlude one renal artery, resulting in a nonfunctioning kidney, and

Fig. 9. Case III. Film obtained two seconds after Fig. 8. The right renal artery (arrow) is now visualized but is smaller and less opaque than in June (compare with Fig. 7).

partially occlude the contralateral artery without altering its function. Since the latter would be responsible for the hypertension, resection of the nonfunctioning kidney would have no effect on the blood pressure. We believe, therefore, that arteriography gives a more complete and reliable portrayal of the pathological anatomy in this disease.

Rapid serial roentgenograms at the rate of one or two films per second were essential for the visualization of the involved renal artery. In Cases II and III, this vessel was demonstrable only on films obtained two to four seconds after the completion of injection of the contrast medium. Since the affected renal artery was smaller, less radiopaque, and revealed fewer branches than normal, it could easily have been missed on the films. In Case II, the right renal artery undoubtedly filled by way of collaterals since the aortic clot extended well above its orifice.

Several additional points of interest were brought out by this study. It is evident that renal artery constriction need not result in infarction, even though the kidney is not functioning and/or has shrunk in size. The pathologist's examination of the poorly functioning contracted left kidney in Case I showed no evidence of infarction and the small nonfunctioning right kidney in Case II contained only

scattered infarcts. The nonfunctioning kidney in Case III was entirely normal. We have also seen examples of complete renal artery occlusion without morphological evidence of infarction.

Of further interest was the fact that in all the arteriograms in this series the aortic obstruction was found immediately distal to one or both of the renal artery orifices. We have also noted this in some of our other cases of aortic thrombosis. Perhaps the large and forceful flow of blood to the kidneys slows for a time the inexorable progression of the thrombus.

It is generally accepted that the occlusion of the aorta results from a thrombus rather than an embolus lodging at the bifurcation ("saddle embolism"). The latter produces quite a different syndrome, catastrophic in nature, with severe pain, shock, and signs of acute arterial insufficiency. That this is not always true is suggested by Case II, in which the evidence strongly favors an embolic origin of the aortic lesion.

Of paramount importance in these cases was the prolonged regression of the severe hypertension which followed nephrectomy. Awareness of the cause of the complicating hypertension should further increase the number of dramatic results obtained by the modern surgical attack on aortic thrombosis—an attack which has successfully controlled many cases of this once hopeless disease.

SUMMARY

Three cases of abdominal aortic thrombosis are presented. In none was significant hypertension present when the patient was first seen. In each patient marked elevation of blood pressure and the retinopathy of severe hypertension subsequently developed. Translumbar arteriograms before and after the onset of hypertension showed retrograde propagation of the thrombus, resulting in partial obliteration of the circulation of a renal artery. In each instance the hypertension was relieved by the removal of the affected kidney. The implications of these findings are discussed.

ACKNOWLEDGMENTS: We are indebted to Dr. James A. Helmsworth for permitting us to report his cases and for his suggestions. We also wish to express our thanks to Drs. Edward A. Gall, Johnson McGuire, and Lee S. Rosenberg for their assistance with the manuscript.

ADDENDUM

Since this paper was presented (December 1956), a case report on "Successful Treatment by Nephrectomy of Hypertension Resulting from Aorticorenal Embolus" has appeared (Stone, P. W., McNally, J. B., Lord, J. W., Jr., and Hinton, J. W.: New England J. Med. **256:** 1076–1079, June 6, 1957). This case was similar to Case III in the present paper in that hypertension developed following resection of a thrombosed abdominal aorta and was apparently due to partial occlusion of the left renal artery by embolization of a portion of the thrombus. The hypertension was relieved by left nephrectomy.

Department of Radiology
Cincinnati General Hospital
Cincinnati, Ohio

REFERENCES

1. GOLDBLATT, H.: The Renal Origin of Hypertension. Publication Number 14, American Lecture Series. Springfield, Ill., Charles C Thomas, 1948.
2. YUILE, C. L.: Obstructive Lesions of the Main Renal Artery in Relation to Hypertension. Am. J. M. Sc. **207:** 394–404, March 1944.
3. FISHBERG, A. M.: Hypertension Due to Renal Embolism. J.A.M.A. **119:** 551–553, June 13, 1942.
4. PRINZMETAL, M., HIATT, N., AND TRAGERMAN, L. J.: Hypertension in a Patient with Bilateral Renal Infarction: Clinical Confirmation of Experiments in Animals. J.A.M.A. **118:** 44–46, Jan. 3, 1942.
5. BEN-ASHER, S.: Hypertension Caused by Renal Infarction. Ann. Int. Med. **23:** 431–436, September 1945.
6. POUTASSE, E. F.: Occlusion of a Renal Artery as a Cause of Hypertension. Circulation **13:** 37–48, January 1956.
7. BLAHD, W. H., MARCUS, R., AND WASSERMAN, D. M.: Case of Malignant Hypertension Secondary to Renal Ischemia. Ann. Int. Med. **37:** 179–185, July 1952.
8. LAFORET, E. G.: Malignant Hypertension Associated with Unilateral Renal Artery Occlusion: 3 Cases. Ann. Int. Med. **38:** 667–688, April 1953.
9. BOYD, C. H., AND LEWIS, L. G.: Nephrectomy for Arterial Hypertension. Preliminary Report. J. Urol. **39:** 627–635, May 1938.
10. BUMPUS, H. C., JR.: Case of Renal Hypertension. J. Urol. **52:** 295–299, October 1944.
11. GOODMAN, H. L.: Malignant Hypertension with Unilateral Renal-Artery Occlusion. New England J. Med. **246:** 8–12, Jan. 3, 1952.
12. SAPHIR, O., AND BALLINGER, J.: Hypertension (Goldblatt) and Unilateral Malignant Nephrosclerosis. Arch. Int. Med. **66:** 541–560, September 1940.
13. LEADBETTER, W. F., AND BURKLAND, C. E.: Hypertension in Unilateral Renal Disease. J. Urol. **39:** 611–626, May 1938.

14. ABBESHOUSE, B. S.: Aneurysm of the Renal Artery: Report of 2 Cases and Review of the Literature. Urol. & Cutan. Rev. **55:** 451–463, August 1951.

15. PASTOR, B. H., MYERSON, R. M., WOHL, G. T., AND ROUSE, P. V.: Hypertension Associated with Renal Artery Aneurysm and Relieved by Nephrectomy. Ann. Int. Med. **42:** 1122–1130, May 1955.

16. Case Records of the Massachusetts General Hospital: Weekly Clinicopathological Exercises: Case No. 41451. New England J. Med. **253:** 824–828, Nov. 10, 1955.

17. PRICE, R. K., AND SKELTON, R.: Hypertension Due to Syphilitic Occlusion of the Main Renal Arteries. Brit. Heart J. **10:** 29–33, January 1948.

18. HOFFMAN, B. J.: Renal Ischemia Produced by Aneurysm of Abdominal Aorta. J.A.M.A. **120:** 1028–1030, Nov. 28, 1942.

19. BLATT, E., AND PAGE, I. H.: Hypertension and Constriction of the Renal Arteries in Man: Report of Case. Ann. Int. Med. **12:** 1690–1699, April 1939.

20. DAVSON, J.: Malignant Hypertension Associated with Hydatid Disease of the Kidney. J. Path. & Bact. **53:** 207–212, September 1941.

21. FARRELL, J. I., AND YOUNG, R. H.: Hypertension Caused by Unilateral Renal Compression. J.A.M.A. **118:** 711–712, Feb. 28, 1942.

22. KOONS, K. M., AND RUCH, M. K.: Hypertension in a 7-Year-Old Girl with Wilms' Tumor Relieved by Nephrectomy. J.A.M.A. **115:** 1097–1098, Sept. 28, 1940.

23. MCCANN, W. S.: Orthostatic Hypertension: The Effect of Nephroptosis on the Renal Blood Flow. J.A.M.A. **115:** 573–578, Aug. 24, 1940.

24. RISKIND, L. A., AND GREENE, H. H.: Renal Torsion with Ischemia Causing Hypertension. J.A.M.A. **119:** 1016–1017, July 25, 1942.

25. SMITH, P. G., EVANS, A. T., ELSEY, E. C., AND FELSON, B.: Translumbar Arteriography: Its Roentgenologic Interpretation. Am. J. Roentgenol. **67:** 183–196, February 1952.

26. FELSON, B.: Translumbar Arteriography in Intrinsic Disease of the Abdominal Aorta and Its Branches. Am. J. Roentgenol. **72:** 597–606, October 1954.

27. LERICHE, R.: De la résection du carrefour aortico-iliaque avec double sympathectomie lombaire pour thrombose artéritique de l'aorte; le syndrome de l'oblitération termino-aortique par artérite. Presse méd. **48:** 601–604, July 24–27, 1940.

SUMMARIO IN INTERLINGUA

Thrombose Aortic Como Causa De Hypertension: Un Studio Arteriographic

Es presentate tres casos de thrombose del aorta abdominal. Nulle significative hypertension esseva presente in ulle de iste casos quando le patientes esseva primo vidite. In omnes, marcate elevation del pression de sanguine e le retinopathia de sever hypertension se disveloppava subsequentemente. Arteriogrammas translumbar ante e post le declaration del hypertension revelava un propagation retrograde del thrombo, con le resultato de un obliteration partial del circulation in un arteria renal. In omne le tres casos, le hypertension esseva alleviate per le ablation del ren afficite.

In iste casos, il esseva le apparition satis subite de grados sever de hypertension que duceva al discoperta del constriction del arteria renal. Ben que arteriographia non es a recommendar como manovra routinari in le studio de patientes hypertensive, le experientia del autores pare suggerer que illo es indicate hypertension de origine recente e de progression rapide.

Nephrotomography in the Investigation of Renal Masses[1]

JOHN A. EVANS, M.D.

THE CHARACTER of a renal mass may now be identified with reasonable exactness by means of translumbar aortography and nephrotomography. Nephrotomography is a combination of rapid intravenous nephrography and body-section radiography (tomography) and, in our opinion, is simpler and less hazardous than aortography. The essential features of the examination as initially used were (*a*) an intravenous aortogram, (*b*) a plain nephrogram, and (*c*) a nephrotomogram. The plain nephrogram proved to have no specific value and therefore has been eliminated. The addition of certain other minor modifications in technic perhaps justifies a recapitulation of the technical aspects of the examination.

1. The patient is positioned on a radiographic table equipped for tomography. Prior to the examination the entire procedure is carefully explained and rehearsed.

2. Preliminary test tomograms are obtained to determine the level which best visualizes the kidneys and to check technic.

3. Following this, a No. 12 gauge Robb-Steinberg angiocardiographic needle is inserted into an antecubital vein.

4. Decholin circulation-time determinations are made to permit an estimate of the time of exposure of the aortogram phase and to familiarize the patient with the taste of Decholin.

5. Twenty-five cubic centimeters of 50 per cent Hypaque or Miokon is then injected, for the purpose of re-enforcing the later nephrogram as well as for visualizing the collecting system at the time of injection of the concentrated medium.

6. A 50 c.c. syringe is filled with one of the concentrated organic iodinated contrast agents to which has been added 5 c.c. of Decholin. We have used 70 per cent Urokon and more recently 90 per cent Hypaque. Preliminary experience with the latter has revealed it to be a highly satisfactory medium, extremely well tolerated. The injection is made as rapidly as possible, according to angiocardiographic technic, the time not exceeding 2.0 seconds. The first exposure is made at the Decholin end-point and is designed to capture the opacified aorta and renal arteries.

7. Immediately following this, the first tomogram is taken at the preselected level. Additional tomograms are then taken at 1 cm. above and 1 cm. below that level.

8. All films are then reviewed. If the findings are not conclusive, we have not hesitated to do a second injection.

TABLE I: ANALYSIS OF 272 CONSECUTIVE NEPHROTOMOGRAPHIC STUDIES
(20 technically inadequate; 252 adequate)

Diagnosis		Errors
Normal	93	4
Cysts	115	5
Neoplasms	44	3

RESULTS

An analysis of the first 272 consecutive nephrotomographic studies revealed that twenty were so inadequate technically as not to permit a diagnosis. In the remaining 252 cases a specific diagnosis was made. Ninety-three studies were interpreted as showing normal kidneys. In this group there were 4 errors. In 1 a superficial (surface) cyst of the kidney was interpreted as an extrarenal mass. This could not be considered a significant error. The other 3 were serious, especially failure to demonstrate 2 carcinomas. One of these was missed because of its small

[1] From the Department of Radiology, The New York Hospital-Cornell Medical Center, New York, N. Y. Presented as part of a Symposium on Contrast Media in the Diagnosis of Retroperitoneal Abnormalities, at the Forty-Second Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2-7, 1956.

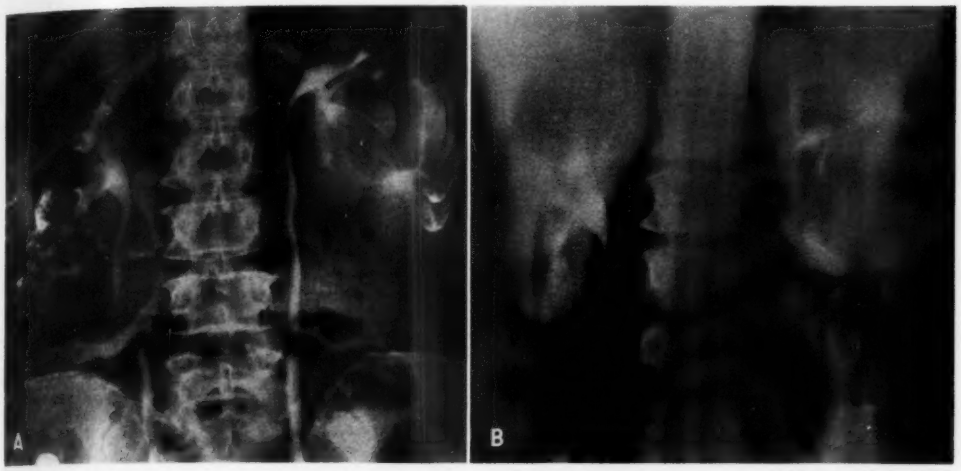


Fig. 1. A 45-year-old female, admitted because of migrating phlebitis. A pyelogram obtained in the course of the hospital work-up showed a mass lesion in the lower pole of the left kidney. The right kidney appeared normal.
A. Retrograde pyelogram.
B. Nephrotomogram showing a sharply marginated lucent defect in the lower pole of the left kidney, characteristic of a cyst. Also seen is a rather large unsuspected cyst in the upper pole of the right kidney.

size (1 cm. diameter); the other because of an imperfect technical study.

In 115 cases a diagnosis of non-neoplastic cyst was made. Forty-three of these were proved at operation, with biopsy, and 19 by aspiration, with Papanicolaou examination of the fluid. In none of the latter group has carcinoma appeared in the subsequent follow-up period. A further 18 patients had unequivocal evidence of polycystic disease of the kidney. There is, then, reasonably conclusive evidence of the correctness of the diagnosis of cyst in 80 cases. In an additional 30 cases with a variable follow-up period there has been no reason to question the diagnosis of simple cyst. The remaining 5 cases showed diagnostic errors and are summarized as follows:

1. Nephrotomography was reported as showing a renal cyst. At operation a mass felt within the kidney was thought to be a neoplasm. The kidney was removed and the pathologic examination showed chronic nephritis only.

2. The nephrotomographic diagnosis was "probable multiple cysts." On exploration only fetal lobulation was found.

3. Examination in this case was considered technically unsatisfactory but a probable diagnosis of cysts in both kidneys was made. The left kidney was explored because of a large defect on the pyelogram and a carcinoma was found.

Fig. 2. A 52-year-old female with a seven-year history of urinary difficulties following hysterectomy. These had been treated by bilateral nephrostomies, plastic repair of the ureters, and reimplantation in the bladder. Urinary tract studies over this period revealed, in addition, a possible mass in the left kidney. Because of this the patient was readmitted for further observation. Retrograde studies were unsuccessful. Nephrotomography showed a large left renal cyst. This was confirmed at operation and decapsulated.

4. Examination was not entirely diagnostic but the findings suggested a

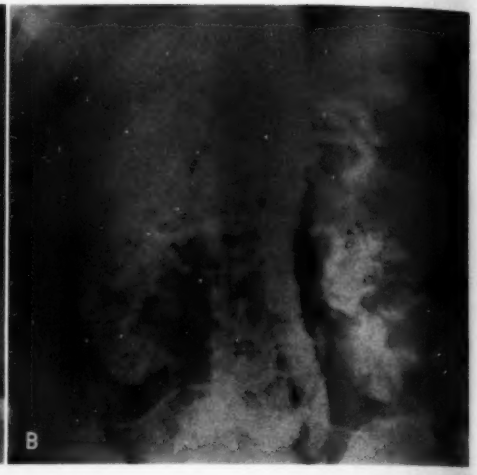


Fig. 3. A 60-year-old female who entered the hospital because of urinary frequency, urgency, and incontinence.

A. Pyelogram obtained during hospital work-up, showing displacement and pressure on the upper-pole collecting system of the left kidney, consistent with the presence of a renal mass. In addition, there is a small calcified deposit in relation to the upper pole. These findings suggested the possibility of neoplasm.

B. Aortogram, showing no abnormal vascular bed within the mass. The calcification was seen to be in the splenic artery.

C. Nephrotomogram demonstrating two clearly defined cysts in the upper pole of the left kidney.

cyst rather than a tumor of the left kidney. Upon exploration carcinoma was found.

5. An equivocal diagnosis of cyst was made, but at operation a carcinoma was discovered.

A diagnosis of neoplasm of the kidney was made and exploration was subsequently carried out in 44 of the 252 cases. In 41, a primary neoplasm of the kidney was found. There were 3 errors:

1. The nephrotomogram was thought to show a carcinoma, but exploration revealed a cyst.

2. Nephrotomographic studies demonstrated a large mass in the right kidney, not thought to be typical of a cyst. Exploration revealed a nodular, irregular kidney and biopsy showed only chronic pyelonephritis.

3. A diagnosis of probable neoplasm with necrosis was made from the nephrotomogram. Operation revealed a cyst.

On the basis of this experience it would appear that nephrotomography has at least a 90 to 95 per cent accuracy in the differentiation of simple cysts and neoplasms in the kidney.

CRITERIA FOR DIAGNOSIS OF RENAL CYSTS

In the nephrotomogram, cysts appear as round, sharply marginated defects in the opacified renal parenchyma. These well circumscribed areas of radiolucency present an easily recognized and constant pattern (Figs. 1–3) and the diagnosis can be made with certainty in their presence. An exception to this observation is a cyst arising from the surface of the kidney.

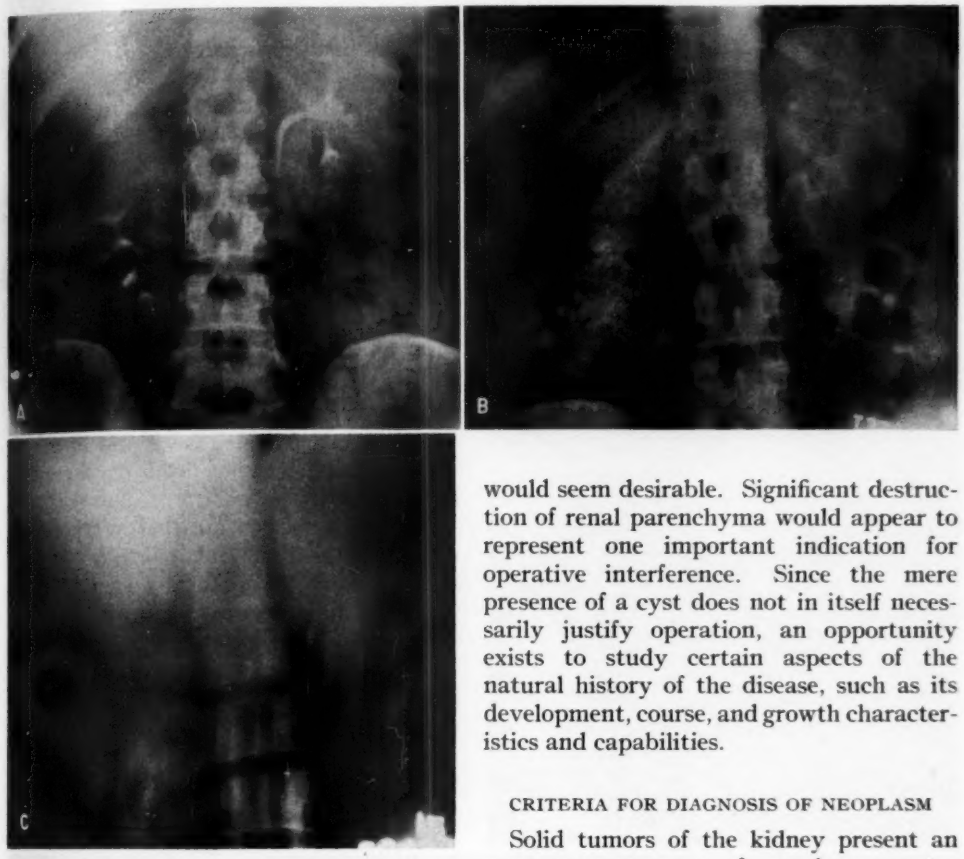


Fig. 4. A 46-year-old woman seen in the medical clinic six weeks before hospital admission because of hypertension.

A. Intravenous pyelogram demonstrating an enlarged right kidney with distortion of the superior calyceal group. There were no urinary symptoms and examination of the urine was negative. Because of the pyelographic finding, however, nephrotomography was done.

B. Aortogram showing pathological vasculature and tumor stain within the mass.

C. Nephrotomogram demonstrating an irregular and uneven opacified mass at the upper pole of the kidney. Diagnosis: Carcinoma of the kidney.

Not being surrounded by renal parenchyma, this does not produce a radiolucent defect. Such a superficial cyst cannot be differentiated from an extrarenal tumor in intimate contact with the kidney. As a result of our experience, it is our opinion that, when a cyst is demonstrated, operation is not necessary to confirm the diagnosis. Operability would then depend on other criteria, the development of which would seem desirable. Significant destruction of renal parenchyma would appear to represent one important indication for operative interference. Since the mere presence of a cyst does not in itself necessarily justify operation, an opportunity exists to study certain aspects of the natural history of the disease, such as its development, course, and growth characteristics and capabilities.

CRITERIA FOR DIAGNOSIS OF NEOPLASM

Solid tumors of the kidney present an opaque appearance of equal or greater density than the adjacent normal parenchyma. In the arterial phase of the examination, an abnormal vascular bed may be identified; if present, it indicates a solid mass rather than an avascular cyst. Degenerating partially necrotic tumors initially presented some diagnostic difficulty. Necrosis and cystic degeneration produced irregular areas of translucency in the partially opacified mass. Extensive necrosis may give an appearance somewhat suggestive of a cyst but with the difference that the areas of radiolucency are blotchy and have irregular, ragged, or ill defined borders (Figs. 4–5).

COMMENT

Nephrotomography is a roentgen method of visualizing the renal vasculature and

renal parenchyma. Its greatest value lies in its ability to demonstrate whether an intrarenal mass is or is not a non-neoplastic cyst. Our experience to date indicates a satisfying degree of accuracy in this respect.

It is recognized that the presence of a simple cyst does not exclude the possibility of a neoplasm, either simultaneously or developing later. This occurrence has not been encountered in the present series of cases. Cysts have, however, not infrequently been found in an unsuspected kidney.

This procedure has been found to have particular usefulness in the study of poor-risk patients in whom the demonstration of a cyst would permit omission of operation. In such cases and in others where operation is not deemed warranted, it has been the policy of our Urology Department to aspirate the cyst percutaneously and submit the fluid to cytological examination. By following such a plan, surgical exploration has been eliminated in a significant number of cases.

We have had no serious reactions and no fatalities in this series of 272 consecutive cases.

The New York Hospital
525 E. 68th St.,
New York 21, N. Y.

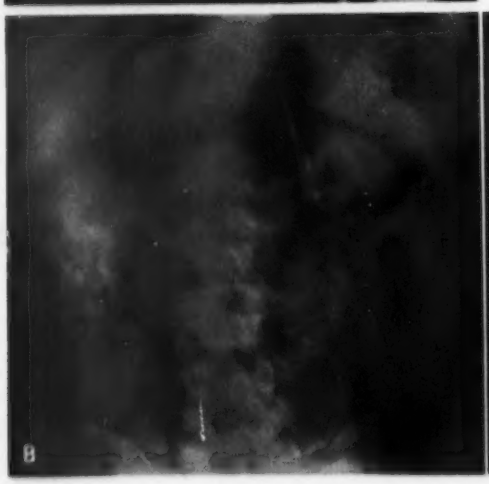


Fig. 5. Patient admitted because of gross hematuria. A. Retrograde pyelogram showing multiple lucent filling defects thought to be blood clots, tumor of renal pelvis, or both.
B. Intravenous aortogram demonstrating abnormal vasculature in the upper pole of the right kidney.
C. Nephrotomogram. A clearly defined, large opacified mass occupies the entire upper pole of the right kidney. This was certainly not suspected from the conventional pyelogram.

SUMMARIO IN INTERLINGUA

Nephrotomographia In Le Investigation De Massas Renal

Nephrotomographia es un combination de rapide nephrographia intravenose con roentgenographia a sectiones corporee (*i.e.* tomographia). Illo include un aortogramma intravenose e un nephrotomogramma.

Duo centos septanta-duo consecutive studios nephrotomographic esseva analysate. Vinti esseva technicamente inadequate como base del diagnose. Le 93 que esseva interpretate como normal includeva 4 errores, 3 de illos seriose. Inter le 115 casos con diagnoses de cyste non-neoplastic, 80 esseva considerate como provate. A parte istos, 30 sublevava nulle question relative al diagnose. In 5 il habeva errores diagnostic. Inter 44 diagnoses de neoplasma renal, 3 esseva erronee.

Es discutite criterios pro le distinction inter cystes e neoplasmas renal. Le methodo describite possede un grado satisfactori de accuratia. Illo es specialmente utile in le studio de altemente compromittite patientes in qui le demonstration de un cyste obviarea un intervention chirurgic.

Nulle serie reactiones e nulle morte occurreva in iste serie.

Experimental Opacification of the Pancreas

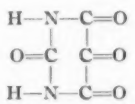
A Preliminary Report[1]

ROBERT SHAPIRO, M.D.

IN RECENT YEARS, contrast radiography has undergone a truly remarkable development and growth. Nonetheless, one organ, *i.e.*, the pancreas, continues to pose a great diagnostic challenge. The present paper is a preliminary report of some experimental studies pertaining to contrast visualization of the pancreas.

Extensive investigation of necropsy material indicated the futility of an indirect approach to the problem. From these studies, it was evident that the vascular branches supplying the pancreatic mass are too small to be satisfactorily demonstrated by aortography or portal venography. Moreover, it is impossible to obtain selective visualization of these vessels by a nonoperative technic. Nor did a simple, consistent, nonoperative procedure for visualization of the major pancreatic ductal system seem feasible.

The earliest direct approach made use of alloxan, the ureide of mesoxalic acid, a compound which has been employed in the production of experimental diabetes mellitus.



Alloxan produces diabetes by virtue of its toxic effect upon the islets of Langerhans. Originally, it was hoped that alloxan could be halogenated and detoxified and, therefore, be used to opacify the islet cells. Repeated attempts in this direction were unsuccessful, however, and were finally abandoned. Actually, this approach was unsound on theoretical grounds, since the islet cells comprise only 2 to 3 per cent of the total pancreatic mass and are not uniform in distribution, being most prevalent in the tail of the gland.

Approximately five years ago, a more logical approach was conceived, based upon the work of Drinker and her co-workers (1). In 1926, these investigators reported the occurrence of fibrotic changes in the pancreatic acinar tissue of 3 cats following oral ingestion of large daily doses of zinc oxide—maximum, 680 to 1,000 mg. ZnO_2/kg. (90 to 270 mg. Zn/kg.). Chemical analysis of the pancreatic tissue of these animals revealed quantities of zinc far in excess of normal. Thus, while the concentration of zinc in the normal cat pancreas averaged 0.026 mg./gm., the concentrations in the fibrotic pancreases were 10 to 20 times as great (0.410, 0.233 and 0.260 respectively). Interestingly enough, the islet cells were unaffected.

In 1938, these observations were confirmed by Scott and Fisher (3), who demonstrated pancreatic acinar fibrosis in 15 cats which received 0.25 to 0.30 gm. of zinc daily for a period of three months. In these experiments, the average concentration of zinc was seven times greater in the fibrotic pancreas than in normal control animals. Again, there were no pathological changes in the islet cells and no significant reduction in the total insulin content of the fibrotic pancreas. These findings were substantiated by the author in his own laboratory prior to initiation of the present study.

Further evidence of the important role of the pancreas in zinc metabolism is provided by studies with radioactive zinc. In a series of experiments dealing with the distribution of radioactive zinc in the tissues of dogs and mice, Sheline, Chaikoff, and Montgomery noted rapid clearance of

[1] From The Department of Radiology of The Hospital of St. Raphael and The Yale University School of Medicine, New Haven, Conn. This study was supported by a grant from The Schering Corporation, Bloomfield, N. J. Presented as part of a Symposium on Contrast Media in the Diagnosis of Retroperitoneal Abnormalities, at the Forty-Second Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2–7, 1956.

the zinc from the plasma following intravenous administration (2, 4, 5). As early as three minutes after injection, each cubic centimeter of plasma contained only 0.025 per cent of the injected zinc, and at thirty minutes after injection less than 0.002 per cent. At ten hours, the zinc had almost completely disappeared from the plasma. Coincident with the rapid disappearance from the plasma, high concentrations of the metal appeared in the liver, pancreas, and kidney. Within two hours post-injection, 43 per cent of the labeled zinc was found in each gram of mouse liver, pancreas, and kidney. In the dog, maximal concentration was somewhat slower, occurring at eight hours.

Another index of the importance of the pancreas in zinc metabolism is afforded by a second experiment dealing with the excretion of radioactive zinc in pancreatic juice. After intravenous injection, a large proportion (as much as 11 per cent in two weeks) of labeled zinc was excreted in the pancreatic juice, while very little (0.4 per cent in 8 dogs) appeared in the bile. These findings indicate not only that zinc is excreted in normal pancreatic juice but, more important, that the acinar cells actually concentrate the zinc. The reason for this is not entirely clear, but preliminary studies suggest that the elaboration of an enzymatic metal protein complex by the acinar cells may be involved.

With these data as a background, the theoretical application to contrast radiography is relatively clear, *i.e.*, the preparation of a halogenated, soluble, and nontoxic zinc compound, in which the halogen acts to produce radiopacity and the zinc cation to direct the compound to the pancreas. In an effort to achieve this end, a number of organic halogenated zinc derivatives were prepared. Although some degree of success has been achieved, measured in terms of pancreatic opacification (Fig. 1), a number of difficulties have been encountered which have not as yet been overcome. In general, these fall under three principal headings, the first two of which are of minor importance.

Fig. 1. Roentgenogram of a rabbit showing opacification of the pancreas one hour following intravenous injection of an organic iodinated zinc compound.

1. *Halogen Toxicity:* In order to obtain superior opacification, it is desirable to have the maximal number of halogen atoms possible in a given compound of relatively low total molecular weight. In the author's personal experiments, all of the 4-atom-iodinated organic compounds studied have shown pronounced toxicity. At present, it appears unlikely that a nontoxic 4-atom-iodinated ring compound will be found in the near future. It is possible, however, to circumvent this difficulty either by combining two di-iodo molecules, *e.g.*, cholografin, or by utilizing a tri-iodo compound.

2. *Physico-Chemical Considerations:* Most of the organic halogenated zinc derivatives studied to date have been unstable, tending to precipitate out to varying degrees upon standing. This is a relatively simple problem, which can be solved by the employment of other types of zinc compounds with entirely different physicochemical properties.

3. *Heavy Metal Toxicity:* This is by far the major difficulty, since all of the common heavy metals, including zinc, are more or less toxic in ionic form in concen-

trations necessary to produce satisfactory radiopacification. Originally, an effort was made to diminish or neutralize this toxicity by the administration of BAL. This, however, proved to be unsuccessful. At present, a number of new organic zinc complexes are being prepared for halogenation. Theoretically, it should be possible to decrease zinc toxicity in this manner and still retain sufficient zinc ionization to direct the compound to the pancreas.

SUMMARY

The problem of experimental opacification of the pancreas has been reviewed. A degree of success has been achieved with certain organic halogenated zinc compounds, but use of these preparations is attended by a number of difficulties, chief of which is the toxicity of zinc.

NOTE: The author is deeply indebted to Dr. Dominick Papa for his invaluable cooperation and help.

REFERENCES

1. DRINKER, K. R., THOMPSON, P. K., AND MARSH, M.: An Investigation of the Effect of Long-Continued Ingestion of Zinc, in the Form of Zinc Oxide, by Cats and Dogs, Together with Observations upon the Excretion and the Storage of Zinc. Am. J. Physiol. **80**: 31–64, March 1927.

2. MONTGOMERY, M. L., SHELINE, G. E., AND CHAIKOFF, I. L.: The Elimination of Administered Zinc in Pancreatic Juice, Duodenal Juice, and Bile of the Dog as Measured by Its Radioactive Isotope (Zn^{65}). J. Exper. Med. **78**: 151–159, September 1943.

3. SCOTT, D. A., AND FISHER, A. M.: Studies on the Pancreas and Liver of Normal and of Zinc-Fed Cats. Am. J. Physiol. **121**: 253–260, January 1938.

4. SHELINE, G. E., CHAIKOFF, I. L., JONES, H. B., AND MONTGOMERY, M. L.: Studies on the Metabolism of Zinc with the Aid of Its Radioactive Isotope. 1. The Excretion of Administered Zinc in Urine and Feces. J. Biol. Chem. **147**: 409–414, February 1943.

5. SHELINE, G. E., CHAIKOFF, I. L., JONES, H. B., AND MONTGOMERY, M. L.: Studies on the Metabolism of Zinc with the Aid of Its Radioactive Isotope. 2. The Distribution of Administered Radioactive Zinc in the Tissues of Mice and Dogs. J. Biol. Chem. **149**: 139–151, July 1943.

6. SHERRILL, J. W., AND WICK, A. N.: Effect of Prolonged Administration of Radioactive Zn^{65} on the Pancreas. J. Lab. & Clin. Med. **41**: 40–42, January 1953.

Hospital of St. Raphael
1450 Chapel Street
New Haven 11, Conn.

SUMMARIO IN INTERLINGUA

Opacification Experimental Del Pancreas: Un Reporto Preliminar

Le problema del opacification experimental del pancreas es passate in revista.

Repetite studios experimental ha monstrate que zinc es excernite in normal succo pancreatic e—plus importante—que le cellulas acinar de facto concentra le zinc. Theoricamente le application de iste factos deberea render possibile le preparation de un pancreatic substantia de contrasto consistente de un solubile e nontoxic composito halogenate de zinc, in que le halogeno effectuarea le radio-opacitate durante que le zinc servirea a diriger le composito verso le pancreas. Ben que un certe grado de successo ha essite attingite in experimentos correspondente, un numero de difficultates remane a resolver. Le plus importante de illos es le toxicitate del zinc.

Es desirabile explorar le possibilitate de preparar compositos in que le toxicitate es reducite in le presentia de un adequate ionisation de zinc pro diriger le composito verso le pancreas.

Cerebral Infarction Simulating Brain Tumor[1]

ERNEST H. WOOD, M.D., and THOMAS W. FARMER, M.D.

DISLOCATION of cerebral structures resulting from cerebrovascular disease most often is produced by atrophy, the displacement being toward the abnormal side. In certain stages of development, cerebral infarction may produce generalized or localized edema of one cerebral hemisphere resulting in contralateral displacement of structures. It is the purpose of this paper to describe manifestations of cerebral infarction which clinically and radiologically simulate brain tumor and may be difficult to differentiate from the more commonly encountered expanding lesions, except through angiography.

PATHOLOGY

Unilateral cerebral edema may result from thrombosis of either the internal carotid or middle cerebral artery. Necropsy studies indicate that internal carotid artery thrombosis may be a far more common occurrence than has been appreciated in the past. One study of 432 consecutive autopsies disclosed that partial or complete occlusion of one or both carotid arteries was present in almost 10 per cent of the subjects (Fisher, 7). Atherosclerosis was found to be the chief cause of carotid occlusion and in the majority of instances the lesion occurred in the carotid sinus (Murphy, 18; Thomson, 25; Shapiro, 22). Men are affected more than four times as often as women (Johnson and Walker, 14).

Variation exists in regard to the extent of thrombosis, the efficiency of collateral circulation, and the resulting degree of encephalomalacia found at necropsy. The pathologic manifestations of infarction also vary, in relation to time. During the first week an acute edema and phagocytic extravasation occur in the affected area, while later the picture is one of loss of substance and gliosis (Hicks and Warren, 12). The timetable of brain response to infarction has been likened to the reaction to trauma (Hicks, 11).

The true expansion of a portion of the brain, resulting from exudation following carotid or middle cerebral artery thrombosis and cerebral infarction, forms the basis for some clinical and radiologic manifestations simulating brain tumor. Even temporal lobe and subfalcial herniation have been reported (Foley and Horenstein, 8, 9). In some instances infarction and encephalomalacia may occur without structural vascular occlusion, as demonstrated by several investigators (Hicks and Warren, 13; Scarcella, 20).

CLINICAL AND RADIOLOGIC INVESTIGATION

Sudden onset of hemiplegia and sensory disturbances, with or without changes in speech, vision, and orientation, are regarded as the usual neurologic changes following cerebral vascular occlusion (King and Langworthy, 16; Gurdjian and Webster, 10). Atypical clinical findings are not rare, however, their occurrence having been appreciated by Cushing (2) in 1900.

The value of radiologic methods for the recognition of carotid thrombosis was demonstrated by Egas Moniz and his associates in 1927 (4), in 4 patients with a clinical diagnosis of brain tumor. Subsequently, several investigators have described changes on plain head roentgenograms and pneumograms indicating an expanding process. These may lead to an erroneous diagnosis if the possibility of infarction is not considered and verified or excluded by angiography. An early report of such findings was given by King (15), who described a patient with roentgen evidence of pineal body changes and ventricular displacement in addition

[1] From the Departments of Radiology and Medicine (Neurology), School of Medicine, University of North Carolina, Chapel Hill, N. C. Accepted for publication in May 1957.

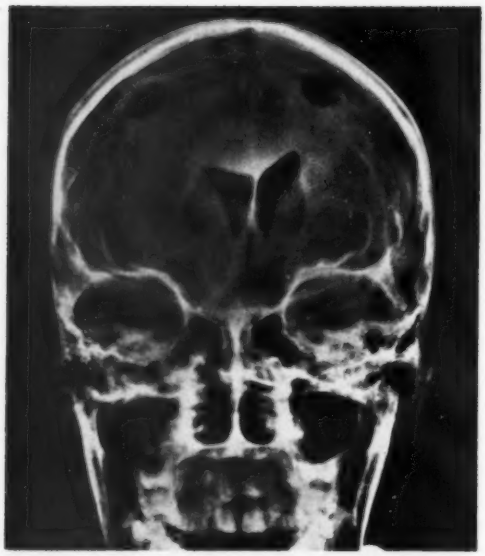


Fig. 1. CASE 1: Ventricular displacement resulting from vascular occlusion. The ventriculogram discloses a generalized shift of the lateral cerebral ventricles 5 mm. to the left, by measurement to the septum pellucidum. No regional deformity of the right lateral ventricle was visible in any of the views to indicate a localized expanding lesion of the right cerebral hemisphere.

to clinical evidence of a space-occupying intracranial lesion. More recently Smiley (23) and Strully and associates (24) have added similar cases to the literature (Table I). Murphy has also described cerebral expansion from occlusive vascular disease (18).

TABLE I: PREVIOUSLY REPORTED CASES OF VERIFIED CEREBRAL THROMBOSIS AND INFARCTION WITH CONTRALATERAL DISPLACEMENT OF CEREBRAL STRUCTURES

Case Reported by	Millimeters of Dislocation from Normal Position		
	Pineal Gland	Anterior Cerebral Artery	Lateral Cerebral Ventricles
King (1951)	3	..	12
Smiley (1952)	..	..	22
Smiley (1952)	..	12	..
Strully *et al.* (1953)	6	..	..

MATERIAL

Four cases recently encountered further exemplify the occasional clinical and radiologic evidence of brain expansion as a result of thrombosis, and the diagnostic problems presented in the absence of angiographic studies. The case histories are presented in abstract form. Case I has been reported in greater detail by Farmer and Swanton (6).

CASE I: A 17-year-old male student was admitted to the hospital because of right frontal headache of four weeks duration. For one week he had been lethargic and for three days had experienced weakness and numbness of the left arm and leg. He had a left hemiplegia. Examination disclosed hypesthesia over the left arm and leg; hyperreflexia and a Babinski reflex demonstrable on the left; anisocoria, with the right pupil the larger. The optic disks and visual fields were normal. A left lower facial weakness was present. Lumbar puncture revealed no abnormality.

Plain head roentgenograms showed normal appearing bony structures and no intracranial calcification. A ventriculogram demonstrated slight ventricular dilatation and displacement of the lateral and third ventricles, 5 mm. to the left of the midline (Fig. 1). No regional deformity of the right lateral ventricle was visible in other views to indicate a localized expanding process of the right cerebral hemisphere.

The patient expired six hours after craniotomy. Pathologic examination disclosed a complete occlusion by recently formed thrombi of both the right anterior and right middle cerebral arteries. Encephalomalacia of the right frontal and parietal lobes was present, with associated right cerebral edema. The ventricular structures were shifted to the left as demonstrated by ventriculography.

CASE II: A 52-year-old man had progressive weakness of the right arm for six months prior to admission to the hospital. During the same period progressive numbness of the right hand developed. He became unable to write. For two months the patient had experienced episodic jacksonian seizures beginning in the right hand, preceded by sensory aura. Twitching of the fingers occurred first, followed by uncontrollable movements of the arm and shoulder and then generalized seizures and loss of consciousness. The seizures increased in frequency and during the days immediately preceding admission were numerous (up to nine in one day).

Moderate weakness of the right hand was demonstrable. There was loss of position sense in the right arm but no other sensory change. Tendon reflexes were equal throughout and no pathologic reflexes were elicited. There was a slight right facial weakness, but otherwise the cranial nerves were intact. Ophthalmologic examination was negative and the cerebrospinal fluid normal.

Plain films revealed no evidence of intracranial disease. On ventriculography the ventricles appeared of normal size. They were displaced 5 mm.

to the right of the midline as measured to the septum pellucidum. There was some depression of the roof of the body and of the atrium of the left lateral ventricle. These findings were interpreted as being the result of a space-taking lesion of the left parietal area.

On intracranial exploration there was no evidence of neoplasm. Rather, craniotomy disclosed occlusion of the left middle cerebral artery. Arteries extending to the posterior frontal and parietal areas were observed as thin, white, firm strands. The leptomeninges on either side of the diseased vessels were opaque. There was no evidence of old or recent subarachnoid or subpial hemorrhage. The exposed brain was abnormally soft, with the greatest pathologic change in the inferior portion of the anterior central gyrus. A 2-cm. segment of an abnormal artery was removed, and several biopsy specimens were taken from the area of greatest cerebral softening.

Histologically the white cord-like band proved to be an artery with an organized and recanalized thrombus occluding the original lumen. The cerebral tissue showed encephalomalacia, with diffuse edema and infiltration of neutrophils, gemistocytes, and gitter cells. Nothing suggestive of neoplasm was found grossly or microscopically. The subsequent clinical course has been that usually associated with cerebral vascular disease.

CASE III: An 80-year-old man suddenly experienced paralysis of the right arm and leg and aphasia, one week before admission to the hospital. Within four days speech and motor power improved markedly, but on the third day prior to hospitalization the patient lost consciousness and paralysis of the right leg and weakness of the right arm recurred.

On admission the blood pressure was 178/84. Right hemiplegia and hemihypalgesia were present, and a right homonymous hemianopsia was demonstrable. Lumbar puncture disclosed no variation from the normal. A plain film of the skull was negative and other radiologic studies were omitted.

During the patient's hospital stay diabetes mellitus was controlled, dehydration was corrected, and he was treated for a pulmonary infection. Death occurred on the sixteenth hospital day.

Necropsy disclosed a thrombus ascending the left internal carotid artery, analogous to that demonstrated in Figure 3. Propagation of thrombus into the anterior cerebral artery was demonstrated. The entire left cerebral hemisphere was edematous and soft. On section, the lateral ventricles were found to be shifted 6 mm. to the right of their normal position. The medial portion of the temporal lobe had herniated through the tentorium.

CASE IV: A 47-year-old man was admitted because of shortness of breath and ankle edema of three weeks duration. He gave a history of hypertension for fifteen years and of two episodes of myocardial infarction, five and four and a half years prior to admission. Paralysis of the left arm and leg had occurred fifteen months before admission, with partial recovery, and there had been a third heart attack three months before.

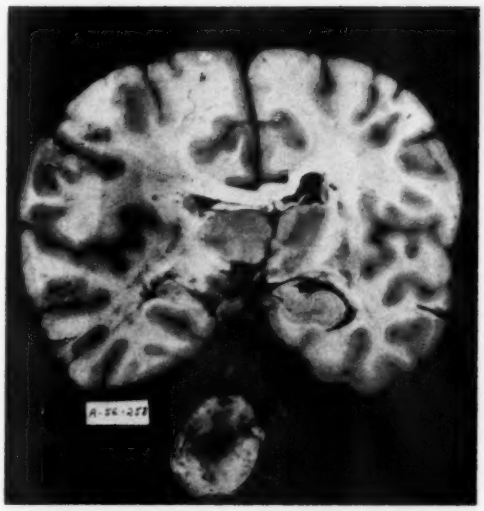


Fig. 2. CASE IV: Cerebral infarction producing marked deformity of the ventricles. A coronal section of the brain obtained at necropsy reveals the generalized deformity of the right cerebral hemisphere produced by encephalomalacia with associated edema. The mechanism of ventricular displacement and subfalcial herniation without localized deformity is evident. (See Fig. 1)

The patient had severe dyspnea, cardiac enlargement, and peripheral edema, with a mild left hemiparesis. A diagnosis of myocardial infarction was confirmed by electrocardiography. Subsequently an embolus developed in the left femoral artery. Two days prior to death there was a rather abrupt lapse into coma and it was not possible to determine the development of further neurologic signs.

Pathologic examination of the brain revealed an embolus of the right internal carotid artery with extension into the right anterior cerebral and right middle cerebral arteries. There was infarction of the right hemisphere with a shift of the midline structures to the left for a distance of 12 mm., as a result of cerebral edema (Fig. 2).

COMMENT

The radiologic finding most frequently associated with cerebral infarction is atrophy. Atrophic changes demonstrable pneumographically are late manifestations of vascular insufficiency. Neurologic symptoms and signs may begin after thrombosis is well established and their

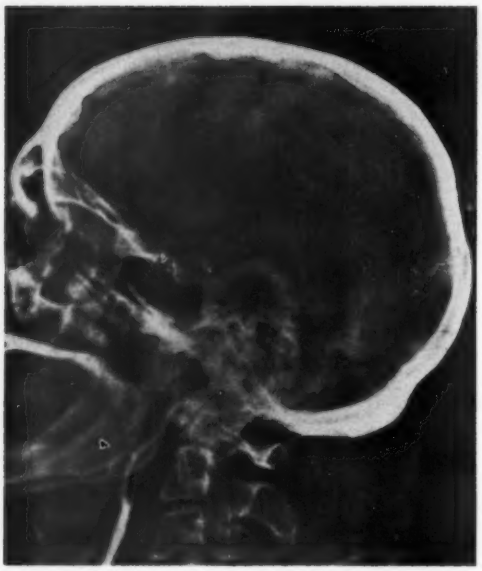


Fig. 3. Internal carotid artery thrombosis. This angiographic study discloses obstruction of the internal carotid artery at its origin from the common carotid artery. Subsequent films revealed normal opacification of the external carotid arborization, but no opaque material entered the internal carotid system.

progress may parallel that of atrophy in a manner simulating brain tumor (Murphy, 18; Elvidge and Werner, 5; Berlin, Tumarkin and Martin, 1; Schlesinger and Taveras, 21). The angiographic findings associated with internal carotid artery occlusion are familiar. Thomson (25) recently described 31 instances of thrombosis of major cerebral arteries demonstrated by arteriography. On the other hand, the changes occurring during early phases of cerebral ischemia resulting from vascular occlusion have not received emphasis in the radiologic literature.

Clinicians now recognize the frequent similarity between cerebral vascular occlusion in its early stages and cerebral tumor (Norris, Alexander and Davis, 19). A number of reports have been made of cases in which plain films and air studies revealed displacement of physiologic calcification or of the cerebral ventricles suggesting the presence of a neoplasm (Table I). The 4 cases described here further illustrate the limitations of displacement of cerebral structures for the identification of expanding processes and the consequent possibility of misguidance in treatment.

Of particular interest are those cases in which cerebral infarction develops without structural occlusion of the arteries. In necropsy studies of 100 patients with infarction, Hicks and Warren (13) found that in 60 per cent the cerebral vessels were not mechanically occluded. The conclusion was drawn that apoplexy is an ischemic disease caused most often by vasospasm, less often by thrombosis, and rarely by embolism, systemic circulatory failure, and other causes.

In some instances edema resulting from the ischemia associated with nonthrombotic infarction is sufficient to cause displacement of ventricular structures similar to that occurring in the thrombotic examples reported here (Scarcella, 20). The customary technics of necropsy, however, do not allow exclusion of carotid thrombosis, since the intra-osseous and cervical portions of the internal carotid artery are not always examined for patency. The high incidence of thrombosis demonstrated by Fisher (7) in routine studies is noteworthy.

Gross edema of an infarcted hemisphere with contralateral shift of cerebral structures, regardless of etiology, may be demonstrated radiologically by one or more of the following observations: (*a*) shift of the pineal gland; (*b*) dislocation of the lateral and third ventricles on pneumography; (*c*) displacement of the anterior cerebral artery (if filled) on angiography. The present study affords surgical or pathologic confirmation of such observations in each instance.

Angiography was performed in one-half of the cases reviewed (Table I) and is the cardinal procedure to indicate the true nature of the pathologic process. The risk in patients with degenerative vascular disease must be calculated, but is small in relation to intracranial exploration. In certain patients in whom the differential diagnosis between cerebral tu-

mor and cerebral vascular disease cannot be ascertained by clinical or laboratory means, cerebral angiography may establish the diagnosis of a carotid or middle cerebral artery occlusion. It may also confirm the presence of neoplasm or subdural hematoma. If the angiographic study is not diagnostic, pneumography may be indicated in selected cases.

Some investigators believe that decompressive surgery is beneficial in relieving the effect of expansion on surrounding structures (Scarcella, 20). Others prefer a direct attack on the vascular obstruction, with removal of emboli or thrombi (Strully, Hurwitt, and Blankenberg, 24). If there is occlusion or severe stenosis of the internal carotid artery in its proximal segment, then surgical vascular anastomosis may be considered (Edwards and Rob, 3). The occluded segment may be excised, followed by anastomosis of the common and internal carotid arteries, anastomosis of the external and internal carotid arteries, or an arterial graft.

With occlusion of the internal carotid artery, and possibly also with occlusion of the middle cerebral artery, anticoagulant therapy has been advocated (McDevitt, 17). Only preliminary observations have thus far been reported, but controlled studies of the use of anticoagulants in cerebrovascular disease are now in progress. Since numerous therapeutic approaches exist, accurate diagnosis by angiography appears to be the basic essential for rational treatment.

SUMMARY

1. Contralateral displacement of intracranial structures is a part of the clinical picture occasionally produced by occlusion of an internal carotid artery or middle cerebral artery. The change is caused by unilateral cerebral edema which follows vascular occlusion and decreased blood flow through the infarcted hemisphere.

2. Four verified cases of cerebral thrombosis are described in which displacement of intracranial structures was demonstrated radiologically or pathologically. Findings in 4 cases described by others are tabulated.

3. Carotid angiography will establish the correct diagnosis in patients with occlusive cerebrovascular disease simulating cerebral neoplasm.

ADDENDUM

Since this paper was submitted for publication, an additional case has been encountered. Plain films revealed lateral displacement of the pineal gland, and angiography disclosed complete occlusion of the internal carotid artery in the neck.

Similar observations, with pathologic confirmation, have been made by C. M. Shaw and E. C. Alvord, Jr., of Houston, Texas. Their material was reported at the Thirty-third Annual Meeting of the American Association of Neuropathologists in June 1957.

School of Medicine
University of North Carolina
Chapel Hill, N. C.

REFERENCES

1. BERLIN, L., TUMARKIN, B., AND MARTIN, H. L.: Cerebral Thrombosis in Young Adults. New England J. Med. **252**: 162–166, Feb. 3, 1955.

2. CUSHING, H. W.: Thrombosis of the Carotid Artery. Bull. Johns Hopkins Hosp. **11**: 260, 1900.

3. EDWARDS, C., AND ROB, C.: Relief of Neurological Symptoms and Signs by Reconstruction of a Stenosed Internal Carotid Artery. Brit. M. J. **2**: 1265–1267, Dec. 1, 1956.

4. EGAS MONIZ: L'encéphalographie artérielle, son importance dans la localisation des tumeurs cérébrales. Rev. neurol. **2**: 72–90, July 1927.

5. ELVIDGE, A. R., AND WERNER, A.: Hemiplegia and Thrombosis of the Internal Carotid System. Arch. Neurol. & Psychiat. **66**: 752–782, December 1951.

6. FARMER, T. W., AND SWANTON, M. C.: [Cerebral Thrombosis with Ventricular Displacement.] Clinical-Pathological Conference. Neurology **5**: 587–593, August 1955.

7. FISHER, M.: Occlusion of the Carotid Arteries: Further Experiences. Arch. Neurol. & Psychiat. **72**: 187–204, August 1954.

8. FOLEY, J. M., AND HORENSTEIN, S.: Bilateral Acute Cerebral Infarction Following Occlusion of the Internal Carotid Artery. Tr. Am. Neurol. A. **80**: 129–132, 1955.

9. FOLEY, J. M., AND HORENSTEIN, S.: Cerebral Infarction as a Cause of Herniation of the Temporal Lobe. Presented at the Annual Meeting of the American Association of Neuropathologists, June 12, 1955.

10. GURDJIAN, E. S., AND WEBSTER, J. E.: Stroke Resulting from Internal Carotid Artery Thrombosis in the Neck. J.A.M.A. **151**: 541–545, Feb. 14, 1953.

11. HICKS, S. P.: Brain Repair; Some Practical Chronological Aspects. South. M. J. **41**: 581–586, July 1948.

12. HICKS, S. P., AND WARREN, S.: Introduction to Neuropathology. New York, McGraw-Hill Book Co., Inc., 1950, pp. 4–11.

13. HICKS, S. P., AND WARREN, S.: Infarction of the Brain Without Thrombosis: An Analysis of 100 Cases with Autopsy. Arch. Path. **52**: 403–412, November 1951.

14. JOHNSON, H. C., AND WALKER, A. E.: The

Angiographic Diagnosis of Spontaneous Thrombosis of the Internal and Common Carotid Arteries. J. Neurosurg. **8**: 631–659, November 1951.

15. KING, A. B.: Massive Cerebral Infarction Producing Ventriculographic Changes Suggesting a Brain Tumor. J. Neurosurg. **8**: 536–539, September 1951.

16. KING, A. B., AND LANGWORTHY, O. R.: Neurologic Symptoms Following Extensive Occlusion of the Common or Internal Carotid Artery. Arch. Neurol. & Psychiat. **46**: 835–842, November 1941.

17. MCDEVITT, E.: Anticoagulants and Their Place in the Treatment of Cerebral Vascular Diseases. [In] Cerebral Vascular Diseases. Transactions of a Conference Held under the Auspices of the American Heart Association and the National Heart Institute, Princeton, January 1954, edited by I. S. Wright and E. H. Luckey. New York, Grune & Stratton, Inc., 1955, pp. 145–156.

18. MURPHY, J. P.: Cerebrovascular Disease. Chicago, Year Book Publishers, Inc., 1954, pp. 143, 156, 159.

19. NORRIS, F. G., ALEXANDER, E., JR., AND DAVIS, C. H., JR.: The Analysis of the Carotid Artery Syndrome. North Carolina M. J. **17**: 8–14, January 1956.

20. SCARCELLA, G.: Encephalomalacia Simulating the Clinical and Radiological Aspects of Brain Tumor; A Report of 6 Cases. J. Neurosurg. **13**: 366–380, July 1956.

21. SCHLESINGER, E. B., AND TAVERAS, J. M.: The Relationship of Some Forms of Cerebral Atrophy and Thrombosis of the Internal Carotid Artery. Tr. Am. Neurol. A. **79**: 97–102, 1954.

22. SHAPIRO, R.: Thrombosis of the Internal Carotid Artery. Radiology **58**: 94–99, January 1952.

23. SMILEY, G. L.: Occlusive Cerebrovascular Disease Simulating Brain Tumor; Angiographic Differentiation. Arch. Neurol. & Psychiat. **67**: 633–640, May 1952.

24. STRULLY, K. J., HURWITT, E. S., AND BLANKENBERG, H. W.: Thrombo-Endarterectomy for Thrombosis of the Internal Carotid Artery in the Neck. J. Neurosurg. **10**: 474–482, September 1953.

25. THOMSON, J. L. G.: Thrombosis of Major Cerebral Arteries. Brit. J. Radiol. **27**: 553–564, October 1954.

SUMMARIO IN INTERLINGUA

Infarcimento Cerebral, Simulante Tumor Cerebral

Occlusion del arteria carotic interne o cerebral medial pote esser sequite per unilateral edema cerebral e un reducite fluxo de sanguine a transverso le area del infarcimento, con consequente displaciamento de structuras intracranial del typo associate con tumores cerebral. Es reportate quatro casos in que tal displaciamentos esseva demonstrate radio logicamente e recognoscite pathologicamente como resultato de thromboses. Quatro simile casos es citate ab le litteratura.

Angiographia carotic es capace a differentiar displaciamento causate per thromboses ab displaciamento de origine neoplastic.

Determination of Disintegration Rate for Gamma-Emitting Isotopes[1]

Gold 198

W. GROSS, A. M., C. WINGATE, M. A., and G. FAILLA, Sc.D.

MEASUREMENTS of disintegration rate of isotopes emitting both gamma and beta rays have usually been based on counts of the beta rays. We are presenting here a method for indirectly determining the rate of emission of gamma rays, with a special type of chamber developed by White, Marinelli, and Failla (1). The ultimate purpose of the present work is to determine the disintegration rate of gamma-emitting K-capture isotopes. This report deals with the preliminary tests of accuracy of the new method performed with a gold-198 source whose disintegration rate is known by other methods.

THEORY

Let us assume initially that a point source of gamma rays emitting energy at a rate CE_0, where C is the number of photons emitted per second and F_0 is their energy, is completely surrounded by a spherical absorbing medium. In passing through the medium the gamma rays lose energy, some of which is transferred to electrons in the medium. The energy loss per second in a spherical shell of the medium having radius r and thickness dr is given by

$$dE = - CE_0 \gamma e^{-\gamma r} dr \qquad \text{(Eq. 1)}$$

where γ is the appropriate absorption coefficient. Thus if dE/dr can be evaluated and if E_0 and γ are known independently, the disintegration rate C can be calculated.

By choosing experimental conditions to satisfy the Bragg-Gray principle, it is possible to determine dE/dr from the ionization produced in a spherical shell air gap in the medium surrounding the source. Two requirements must be satisfied. First, the air shell should be located at a radius from the source several times the maximum range of secondary electrons in the medium in order to avoid the non-uniform flux difficulties which occur at small radii, as discussed by Failla (2). Second, the ionization current per unit gap width must be determined for zero gap because it is not constant even for gaps small enough to leave the electron flux undisturbed (1). Practically, this is achieved by measuring the current at different gaps and extrapolating to zero gap. Since the non-uniform flux difficulty is purely geometric, the first condition is still satisfied if the inner portion of the medium is replaced by air, leaving only a spherical shell of medium between the source and the air shell gap. This reduces the attenuation of the photons. However, in this case the remaining spherical shell of medium must be sufficiently thick to establish equilibrium for the electron flux.

Under these conditions, the rate of energy transfer to the air gap is the same as to the adjacent medium if the difference in composition and density is taken into account. Then the Bragg-Gray relation is:

$$CE_0 \gamma e^{-\gamma r} = NWS \qquad \text{(Eq. 2)}$$

where N is the number of ion pairs produced in the air gap per second per centimeter, W is the average energy lost by an electron per ion pair formed in air, and S is the relative stopping power per centimeter for the medium compared to air.

EXPERIMENTAL

The construction of a typical spherical shell ionization chamber is shown in Figure 1. The shells, made of Lucite in hemispherical sections which interlock accurately, were rendered conducting by a thin layer of colloidal graphite on all

[1] From Columbia University, New York, N. Y. Based on work performed under Atomic Energy Commission Contract AT-30-1-GEN-70. Presented at the Forty-second Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 2–7, 1956.

surfaces except on the outer shell below the arrows shown in Figure 1. A metal collar (not shown) was added at the base of the outer sphere for convenience in applying the collector potential. The inner shell served as the collecting electrode, with contact established *via* an aluminum rod in the center of an insulated stem. Insulation from the guard ring was achieved by machining a groove around the cone-shaped stem of the inner sphere through the graphite coating. The

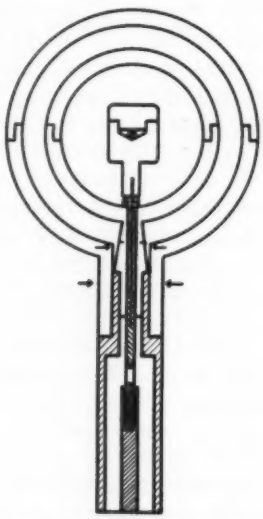


Fig. 1. Spherical extrapolation chamber.

cone surface below the groove which serves as the guard ring was grounded *via* the external aluminum shield of the chamber stem.

Four such chambers were constructed having identical inner shells (3 cm. outside diameter, 0.3 cm. wall). The outer shells, having the same wall thickness, were of different diameters so that the air gap varied from 0.75 mm. to 4.5 mm. The thickness of the inner shell was sufficient both to absorb the most energetic beta rays from gold 198 and to establish the equilibrium flux for electrons produced by the gamma rays.

The source, a highly pure gold sphere of 0.086 cm. diameter, irradiated in the pile at Brookhaven National Laboratory, was located at the center of each chamber in turn by means of a balsa wood container mounted on a centering pin, as shown in Figure 1. The ionization current was determined by use of a Lindemann-Ryerson electrometer as a null detector with the Townsend capacity-compensation scheme. The gap width was determined from the electrical capacitance, measured simultaneously with the ionization current by the Failla method, and from the chamber radii.

The current per unit gap width at zero gap, necessary for calculating N in Equation 2, was determined by fitting the experimental curve of current *vs.* gap width (I vs. L) to a polynomial of the form

$$I = a + bL + cL^2 + dL^3 \qquad \text{(Eq. 3)}$$

Since at zero gap $I = 0$, then $a = 0$, and the desired slope is given by the constant b.

Duplicate measurements on each of four gold-198 sources were made as described. For purposes of comparing the activity value obtained with that given by another method, the solid sources were dissolved in small amounts of aqua regia. As a check, two of the sources were dissolved in one solution. The three resulting solutions were diluted sufficiently to bring the density very close to unity. An aliquot of each of these solutions and of a calibrated gold-198 solution (in mc/ml.), supplied by the National Bureau of Standards, were compared in a special ionization chamber.

SOURCE ABSORPTION

Corrections for self-absorption in the source due to photoelectric and Compton processes were obtained from the theoretical curves of Rossi and Ellis (3). They calculated the fractional dose (or energy absorbed per unit volume) as a function of a generalized co-ordinate μr, where μ is the absorption coefficient and r is the radial co-ordinate, for a spherical source with uniformly distributed activity obeying an exponential absorption law. By integration of their curves over the volume of the source, the total fraction of the energy self-absorbed by the source as a function of

μR, where R is the radius of the source, was obtained. This function is shown in Figure 2.

Corrections for only the 0.412-MEV gamma ray were made, since the total self-absorption is small (approximately 10 per cent) and since only 1 per cent of the disintegrations involve gamma rays of other energies. By interpolation in the tables given by White (4), 2.14 $cm.^{-1}$ was obtained as the photoelectric absorption coefficient in gold for the 0.412 MEV gamma rays of gold 198. From Figure 2 it was found that 6.4 per cent of the initial gamma-ray energy is photoelectrically self-absorbed in the source.

From the calculations of Nelms (5), the total Compton coefficient for 0.412 MEV gamma rays in gold is 1.46 $cm.^{-1}$. From Figure 2 it is apparent that 4.4 per cent of the initial photons undergo Compton scattering. These scattered photons have a calculated average energy of 0.282 MEV, and for simplicity of calculation they may be treated as monoenergetic, since the interaction with the chamber wall is very nearly the same for such a monoenergetic beam as for the actual distribution. Also, some of the scattered photons are photoelectrically absorbed in the source. By the same method of calculation it is found that approximately 84 per cent of the initially scattered photons escape from the source. Second order Compton scattering is negligible.

Summarizing these calculations, the 0.412 MEV gamma rays emitted initially may be considered in two components. One fraction, $0.936 \times 0.956 = 0.895$, which escapes both photoelectric and Compton processes, emerges with energy 0.412 MEV. Another fraction, $0.044 \times 0.84 = 0.037$, representing the scattered photons that emerge, has an average energy of 0.282 MEV.

ENERGY DELIVERED

To calculate the energy imparted to the wall, one must consider the processes occurring in the wall for each of the incident gamma energies. For a material

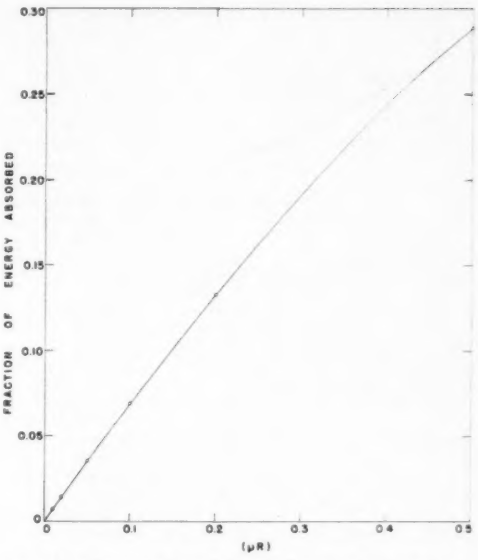


Fig. 2. Fraction of energy self-absorbed by gold as a function of μR

of low atomic number, such as Lucite, and for the photon energies involved in gold-198 decay, only the electronic Compton coefficient σ_a must be considered.

TABLE I

(*a*) Photon Energy (MEV)	(*b*) Fraction Initially Emitted	(*c*) Fraction Escaping Source	(*d*) σ_a for Lucite ($cm.^{-1}$)	(*abcd*) Energy Delivered (MEV/cm.)
0.282	...	0.037	0.0364	0.00038
0.412	0.998	0.895	0.0375	0.01380
0.677	0.008	1.0	0.0374	0.00020
1.089	0.002	1.0	0.0349	0.00008
				0.01446

In Table I are listed the gamma ray energies and abundance from the disintegration scheme of Elliott *et al.* (6), the corrections for self-absorption as discussed, the absorption coefficient, σ_a, for each energy in Lucite as calculated from Nelms' data (5), and, finally, the energy delivered to the wall by each component of the incident gamma ray beam. The summation of the final column represents the energy which would be delivered per centimeter of Lucite adjacent to the gap per disintegration, if the attenuation were negligible.

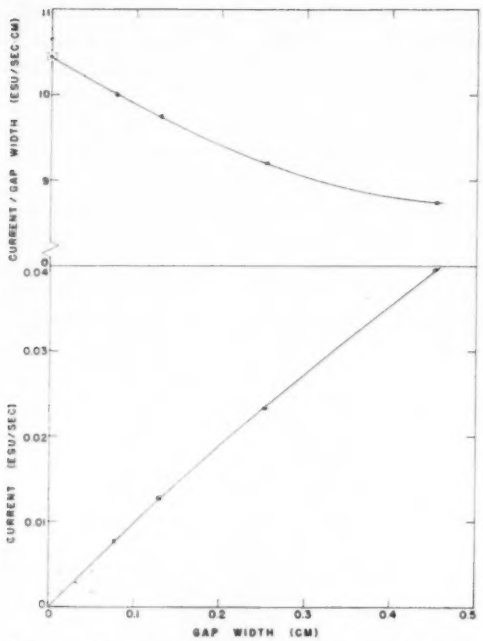


Fig. 3. Current and current per unit gap width as a function of gap width.

Actually, for each of the energies listed in the table the photon beam is reduced to 0.989 of its incident intensity in traversing the Lucite wall. The rate of energy loss in the medium (the left side of Equation 2) may now be written $C \times 0.989 \times 0.01446$ MEV/cm. sec.

For the right side of Equation 2 a W value of 33.6 ev. per ion pair (7) was used and a value of 1.131 for S calculated from the experimental work of Hersh and Paterna as quoted by Failla (8).

DISCUSSION

Typical curves of data obtained for one of the gold-198 sources are presented in Figure 3, showing the degree of duplication achieved in reassembly of the chamber. The lower curve of current *versus* gap width passes through the origin and was used to determine the ratio of current per unit gap width at zero gap by the method discussed above. The upper curve, showing the experimentally determined ratios of current divided by gap width for various gaps, illustrates the behavior of this function. The value in brackets at zero gap obtained from analysis of the lower curve is included for comparison.

TABLE II

Gold-198 Source	Millicuries RRL (solid)	Millicuries NBS (solution)	Ratio RRL/NBS
1	14.2_7	14.1_2	1.01_1
2	14.8_8	14.6_2	1.01_8
3	13.9_7	...	...
4	14.3_8	...	...
3, 4	$(28.3_)$*	27.8_2	1.01_7

* Sum of individual measurements.

Table II shows the millicurie values for the gold-198 sources calculated from the disintegration rates obtained by the method described herein (designated RRL) and the millicurie values for the corresponding gold-198 solutions based on comparison with a reference solution from the National Bureau of Standards (designated NBS). The ratios of results show a spread of less than 1 per cent, with a consistent difference of approximately 1.5 per cent between the two methods.[2] It is estimated that the overall error of this new method should not exceed 4 per cent in the case of gold 198. Since the Bureau of Standards assigns a possible error of 3 per cent to its calibration, the observed difference is well within the combined errors of the two methods compared.

The determination of disintegration rates by the method discussed above depends upon the proper choice and accurate knowledge of the appropriate absorption coefficients. The energy of the gamma rays and additional information about the disintegration scheme must be known. In some cases this method offers a more convenient means of determining the disintegration rate of gamma-emitting isotopes than the more conventional methods.

[2] The effects of bremsstrahlung and characteristic x-rays induced by the beta rays in the gold source can be estimated from the data of Starfelt *et. al.* (Starfelt, N., Cederlund, J., and Liden, K.: The Yield of Characteristic X-rays Excited by β-rays. Internat. Appl. Radiation and Isotopes **2**:265-273, 1957). They total about 0.5 per cent, which has not been included here but would bring the present values into closer agreement with the National Bureau of Standards value.

It may be of interest to point out that the spherical ionization chambers can also be used to determine the specific energy emission of gamma-emitting isotopes, as described for radium by White, Marinelli, and Failla (1). With the extrapolation technic described herein, such measurements are simpler. In general, the method gives good accuracy, involves small corrections, and does not require a strong source. It may therefore be preferable in many cases to methods currently employed.

SUMMARY

A method is described for obtaining disintegration rates of gamma-emitting isotopes from the rate of energy transfer to a surrounding medium as indicated by ionization measurements in a series of concentric spherical shell ionization chambers of varying gap widths. By calculating the expected rate of energy deposition in the medium per disintegration, the number of disintegrations is obtained. The accuracy of the method has been tested with gold 198, whose disintegration rate was known from other methods.

ACKNOWLEDGMENT: The authors express their thanks to Dr. James B. Campbell for use of his gold seeds and handling equipment and to Mr. Lloyd K. Dutton for his careful construction of the ionization chambers used in this experiment.

Radiological Research Laboratory
630 W. 168th St.,
New York 32, N. Y.

REFERENCES

1. WHITE, T. N., MARINELLI, L. D., AND FAILLA, G.: A Measurement of Gamma Radiation in Roentgens. Am. J. Roentgenol. **44**: 889–903, December 1940.
2. FAILLA, G.: The Distribution of Energy Imparted to a Homogeneous Medium Non-uniformly Irradiated. Radiation Res. **5**: 205–215, September 1956.
3. ROSSI, H. H., AND ELLIS, R. H., JR.: Distributed Beta Sources in Uniformly Absorbing Media. Nucleonics **7**: 18–25, July 1950; 19–25, August 1950.
4. WHITE, G. R.: National Bureau of Statistics Report 1003.
5. NELMS, A. T.: National Bureau of Statistics Circular 542.
6. ELLIOTT, L. G., PRESTON, M. A., AND WOLFSON, J. L.: Disintegration of Au^{198}. Canad. J. Physics **32**: 153–165, February, 1954.
7. GROSS, W., WINGATE, C., AND FAILLA, G.: Average Energy Expended in Producing Ion Pairs—S^{35} Absolute Value for Air. Radiology **66**: 101, January 1956.
8. FAILLA, G.: Chapter in: Progress in Nuclear Energy, Medical Sciences, Vol. 1. New York, McGraw-Hill Book Company, Inc., 1956.

SUMMARIO IN INTERLINGUA

Determination Del Rapiditate De Disintegration De Isotopos Emittente Particulas Gamma Auro 198

Es describite un methodo pro determinar le velocitate del disintegration de isotopos emittente particulas gamma, super le base del intensitate del transferimento de energia a un medio circumjacente, reflectite in mesurationes del ionisation in un serie de concentric cameras de ionisation con varie aperturas. Per calcular le expectate deposition de energia per disintegration, le numero del disintegrationes es obtenite. Le accuratia del methodo esseva verificate con auro-198 cuje rapiditate de disintegration esseva cognoscite super le base de altere methodos.

Abdominal and Pelvic Pneumography[1]

JAMES W. BUICE, M.D.,[2] and DAVID M. GOULD, M.D.[3]

THE DIAGNOSTIC potential of the roentgen visualization of the peritoneal cavity and its organs by means of gas insufflation (or pneumoperitoneum) has failed to receive the emphasis which the procedure warrants. Many radiologists have seen tuberculous patients with therapeutic pneumoperitoneum, but relatively few have used gas insufflation as a diagnostic procedure. If physicians better appreciated its ease and safety, its use would become widespread.

HISTORY

The following brief outline includes the more important historical landmarks in the development of abdominal peritoneal pneumography:

1902. Kelling (1) injected air into the peritoneal cavity for the first time to obtain a better view of abdominal organs at the time of endoscopy.

1912. Weber (2) was the first to combine artificial pneumoperitoneum with roentgenographic examination.

1919. The method by this time was called pneumoperitoneum and was introduced into the United States by Stewart and Stein (3).

1921. Alvarez (4) introduced the rapidly absorbing carbon dioxide gas for injection.

1926. Stein (5) employed iodized oil to outline the uterine cavity and fallopian tubes in combination with pneumoperitoneum.

TECHNIC

The most suitable gas is nitrous oxide because of its lack of irritating qualities and because it is absorbed with remarkable rapidity. The relative solubilities of various gases in 100 ml. of water at 37° C. are as follows (6): Helium 0.87 ml., Nitrogen 1.28 ml., Oxygen 2.5 ml., CO_2 5.45 ml., N_2O 44.0 ml. Nitrous oxide is thus almost 35 times more soluble than nitrogen and approximately 18 times more soluble than oxygen. It is 8 times more soluble than carbon dioxide, the gas now most widely used for diagnostic studies.

An 18-gauge lumbar puncture needle is inserted through the abdominal wall, usually at the lateral border of the left rectus muscle, approximately 2 cm. below the umbilicus. The puncture site need not be exact, though it is important to avoid puncturing scars, incisions, or areas where disease is suspected locally. Insufflation may be done with a large syringe. We have found it more convenient, however, to use a two-bottle gravitational device similar to a common type of pneumothorax apparatus (Fig. 1). This technic of insufflation is in essence the same as that described by Teschendorf (7) and others. In women the insufflation may be carried out by cul-de-sac puncture (8) or the transuterine route (9). We have found transabdominal puncture to be more convenient to the operator and to the patient.

Immediately after insufflation, the patients are positioned for film studies. The involved portion of the abdominal cavity is placed uppermost, so that the gas will gravitate toward it. Multiple projections in several different positions will often yield additional information. Lesions within the pelvis are best delineated with the patient prone in a 45° Trendelenburg position so that the pelvis will be filled with gas. The tube is angled 15° toward the feet, and the central ray is usually parallel to the inlet of the pelvis (Fig. 1).

[1] From the Department of Radiology, University of Arkansas Medical Center, Little Rock, Ark. Accepted for publication in May 1957.

[2] Resident in Radiology.

[3] Professor and Head of Department of Radiology.

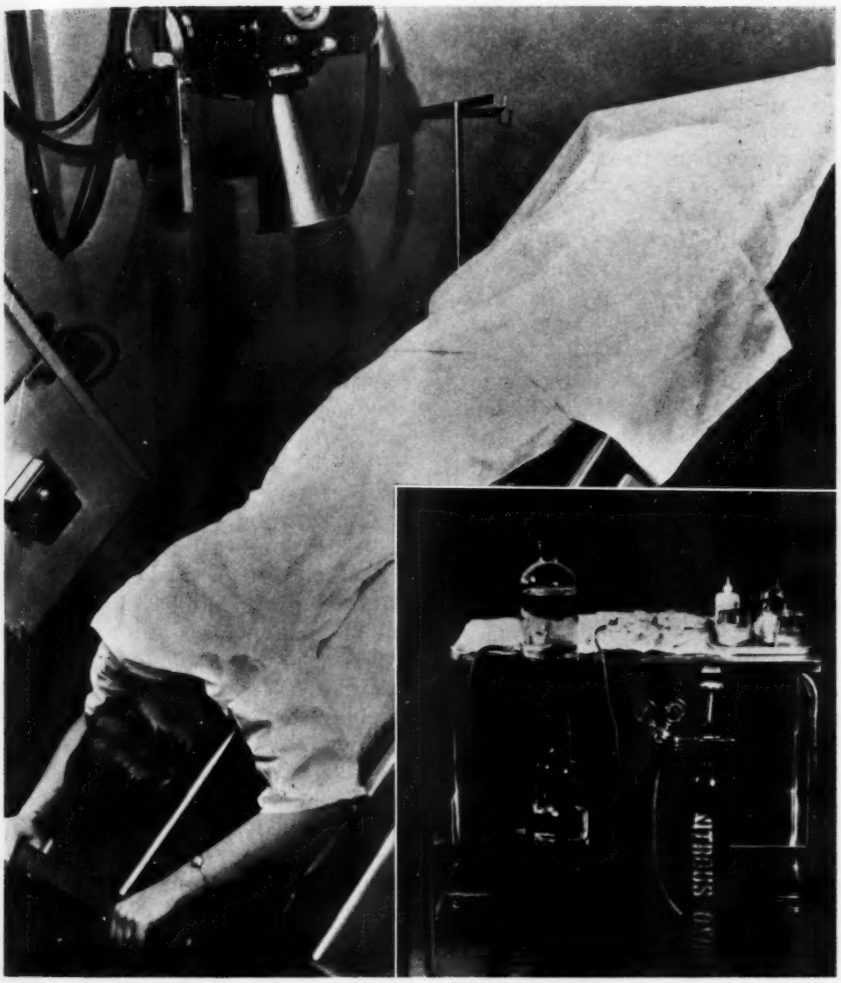


Fig. 1. Patient in position for pelvic pneumography. Apparatus for procedure shown in inset.

The whole procedure seldom requires more than fifteen minutes. Most of our studies have been on out-patients, who are allowed to go home as soon as the films are developed and checked. The only preparation is a low cleansing enema. The patients are instructed to void at the time they expel the enema.

INDICATIONS

Failure of routine examinations to elucidate the nature of a disease process is sufficient indication for a diagnostic pneumoperitoneum. With intraperitoneal gas, the contours of both the peritoneal cavity and the peritonealized surfaces of the abdominal and pelvic viscera are clearly defined. In the pelvic cavity one can visualize the uterus, fallopian tubes, ovaries, parametria, lateral pelvic wall, bladder, and rectum. One may recognize such entities as ectopic tubal pregnancy, extrauterine pregnancy, ovarian agenesis, the adrenogenital syndrome, pseudohermaphroditism, endometriosis, and leiomyomata.

This examination has particularly important possibilities when full information cannot be gained through clinical or pelvic

examination, as in obese patients, women with a stenotic or virginal introitus, infants, children, and unco-operative patients.

In the upper abdomen, the inferior surface of the diaphragm, the liver, and spleen show particularly well. Often one may obtain a good appreciation of the fundus of the stomach, gallbladder, kidneys, and pancreas. Obliteration of the peritonealized planes suggests an inflammatory lesion such as a subphrenic abscess. In studying neoplastic lesions, one can recognize local extensions, implants, and metastases. Small amounts of fluid in the abdominal cavity—blood or ascites—are revealed by a gas-fluid level. Bowel obstructions, adhesions, volvulus, urachal and umbilical anomalies, and Richter's hernia into the anterior abdominal wall may also be demonstrated.

CONTRAINDICATIONS

The contraindications to pneumoperitoneum most frequently mentioned in the literature (10, 11) are: advanced age of the patient, with or without poor cardiac status; the presence of local or diffuse peritonitis; a mass completely filling the abdomen or pelvis.

Since nitrous oxide is safe and free of side-effects compared with other gases, we have tended to be quite skeptical of these contraindications. We do not exclude patients from this procedure unless their condition is critical. Patients with poor cardiac reserve have tolerated the insufflation without difficulty, although in such cases we usually limit the volume of gas to 1,000 ml. Some cardiac patients, it has been shown, can tolerate prolonged forced pneumoperitoneum with air or nitrogen (12). Nitrous oxide exerts only transitory increased intra-abdominal pressure. If respiratory embarrassment were to occur, it could be quickly relieved by reinserting the spinal needle into the peritoneal cavity to allow the gas to escape.

We have not yet used the procedure in the presence of diffuse peritonitis, but we have found it entirely safe with localized peritonitis and abscesses. Many of our patients have had acute pelvic inflammatory disease and have shown no adverse effects.

Some patients entered the clinic with huge abdominal or pelvic masses, so large that it was impossible to determine their origin. We obtained a great deal of information by pneumoperitoneum in these cases. Contrary to the opinion expressed in previous articles, we believe that the finding of a large abdominal or pelvic mass constitutes an indication rather than a contraindication for a diagnostic pneumoperitoneum.

COMPLICATIONS

Diagnostic pneumoperitoneum is a relatively harmless procedure. Carelli (13) and Stein (14) each reported more than 800 examinations without a single bowel puncture or other complication. In our series of 110 patients, no untoward reaction occurred. Even minor complications, such as nausea, vomiting, vertigo, and pain, were absent when nitrous oxide was used. Some patients were aware of slight diaphragmatic irritation when they stood erect immediately after the injection of gas. This discomfort is avoided by maintenance of the recumbent position for twenty to thirty minutes.

The complications described in association with therapeutic pneumoperitoneum (15) theoretically should apply to diagnostic pneumoperitoneum. From a practical standpoint, the procedures are not comparable. In the diagnostic procedure, the gas (if nitrous oxide is used) remains one to two hours. In the therapeutic procedure, it may remain from one to two months. Diagnostic pneumoperitoneum is generally done once, whereas the therapeutic pneumoperitoneum is repeated many times, sometimes over a period of years.

If the highly soluble nitrous oxide is used, death from gas embolus is rather unlikely. Recently Stauffer (16) injected carbon dioxide intravenously for angiocardiography in the dog and man. He observed no ill effects. Since nitrous oxide

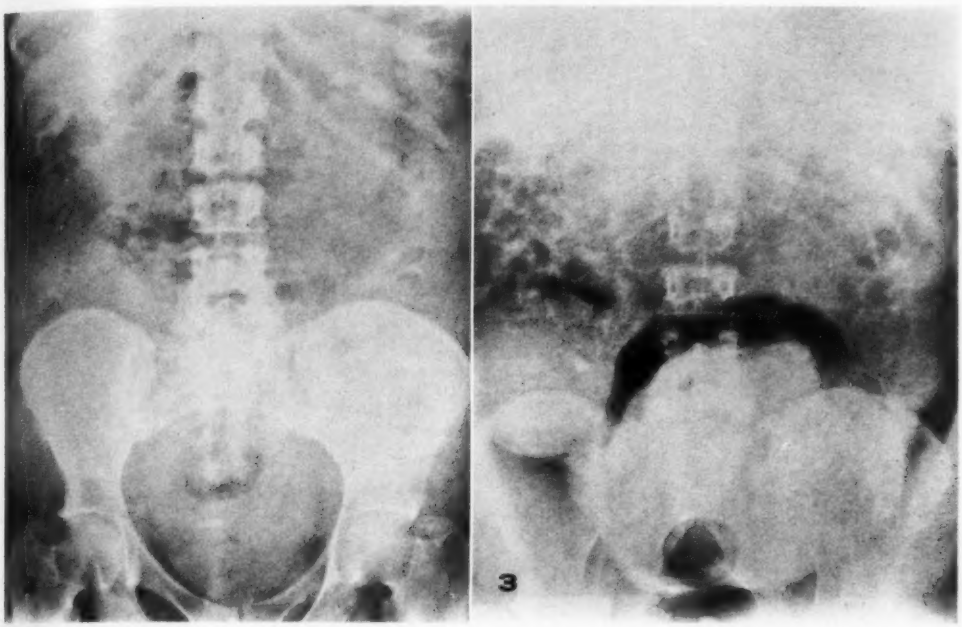


Fig. 2. Case I: Bilateral ovarian dermoids and uterine fibromyomata. On the original plain film very faint radiolucent fatty tumors with calcification were barely visible.
Fig. 3. Case I: Bilateral ovarian dermoids and uterine fibromyomata plainly outlined by gas.

is eight times more easily dissolved than carbon dioxide, it would be even less likely to cause gas embolism.

CASE REPORTS

We used pneumoperitoneum in 110 patients from March 1956 to March 1957. The youngest was an infant twenty-nine days old, with agenesis of both ureters and hypoplasia of the kidneys and bladder. Diagnostic pneumoperitoneum and presacral gas injection were performed simultaneously without ill effect, despite the patient's poor condition. The oldest patient was seventy-two years old. The majority were women in their fifth and sixth decades, and most of the examinations consisted of pelvic pneumography both with and without hysterosalpingography.

CASE I: A woman aged 42 had a slow-growing pelvic and lower abdominal mass. Physical examination revealed a firm, non-tender, fixed nodular mass rising out of the anatomic pelvis to the umbilicus. No other masses could be palpated within the abdomen or pelvis. A plain film of the abdomen revealed a large pelvic tumor and questionable calcific densities in both lower quadrants. The possibility of bilateral ovarian dermoids associated with uterine fibromyomata was suggested (Fig. 2). Following pneumoperitoneum, a greatly enlarged uterus and definite cystic lesions containing calcium and fat were well visualized (Fig. 3). A diagnosis of bilateral ovarian dermoids was definitely established, although the condition was not suspected clinically and the evidence on the routine films was only questionable.

CASE II: A 51-year-old woman had a carcinoma of the colon removed by abdominoperineal resection in January 1955. In May 1956, she complained of pain within the left pelvic region. Pelvic examination could not be performed because of stenosis of the vagina following operation and irradiation. A pneumoperitoneum showed mass-like thickening along the left lateral pelvic wall, with the bladder fixed to the mass (Fig. 4). The diagnosis was recurrent growth of previously removed carcinoma of the colon.

CASE III: A woman aged 51 entered the hospital because of a slowly enlarging mass in the right flank. On physical examination this was found to fill the entire right abdomen. Plain abdominal films, together with routine studies, including pyelograms, revealed a large mass occupying the right upper quadrant. It could not be determined

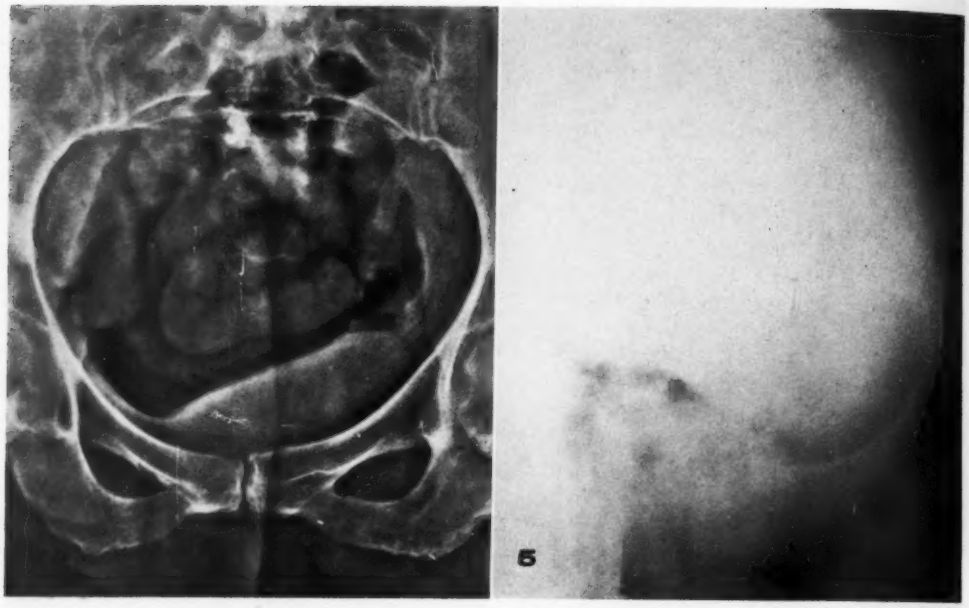


Fig. 4. Case II: Recurrent carcinoma of colon. Note thickened left lateral pelvic wall and distortion of bladder.
Fig. 5. Case III: Retroperitoneal liposarcoma weighing 19 pounds, lateral view. Note line of demarcation between liver and tumor.

Fig. 6. Case IV: Adhesions between the bowel and the anterior abdominal wall, two years following hysterectomy.

whether or not this was an enlarged liver. Pneumoperitoneum showed the mass to be separate from the liver; its contour suggested a cyst (Fig. 5). At surgery a retroperitoneal liposarcoma weighing 19 pounds was found.

CASE IV: A thirty-nine-year-old woman entered the out-patient clinic complaining of "heaviness" within her pelvis. She had had a bilateral oophorectomy and total hysterectomy two years previously. Pelvic examination was inconclusive. Pneumoperitoneum revealed numerous adhesions between the bowel and the incision in the anterior abdominal wall (Fig. 6).

DISCUSSION

Free gas in the peritoneal cavity can be used as an exploratory medium for any peritonealized organ in the abdomen or pelvis. The inferior surface of the diaphragm, the subdiaphragmatic space, the liver, the spleen, and the fundus of the stomach can be outlined. In diagnostic radiology the fundus of the stomach, since it cannot be palpated or manipulated easily, is not always clearly and completely visualized by the use of internal contrast

media such as barium sulfate and carbonated drinks. If enough gas is placed in the upper abdomen to collapse the fundus around the opaque barium sulfate, one may more clearly see small malignant lesions and other pathologic conditions.

With the patient appropriately positioned, one can easily study various organs such as the kidneys, the gastrointestinal tract, the spleen, and the pancreas. The anterior abdominal wall, including the umbilical region, is particularly well defined by this method. In the pelvis the reproductive organs are well suited for this type of study. Double-contrast effects can be obtained by selecting proper radiolucent or opaque media for demonstration of such organs as the bladder, the uterus, the colon, and the ureters.

This method may have particular value in cancer of the cervix and uterus. Not only can the true extent of the cancer be determined but also the implantation of radium and the injection of radioisotopes can be better directed as a result of accurate determination of the size and shape of the pelvic structures and the presence of associated abnormalities. Furthermore, since the free gas can compress the bladder and rectum away from the uterus, it is possible to prevent these structures from obtaining a high dose of undesirable radiation. Fistulas may thus be prevented.

SUMMARY

Nitrous oxide gas insufflation to outline the abdominal pelvic organs has been found a safe and simple procedure. It can be done on outpatients because of the extremely rapid absorption of the gas. Diagnostic potentialities are frequently opened up when ordinary opaque media have failed. The combined use of an opaque medium to demonstrate the lumen of hollow organs and radiolucent gas to outline their external contour is highly recommended. Although pneumography is not a new diagnostic procedure, minor complications experienced with slowly absorbable gases have prevented its widespread use.

David M. Gould, M.D.
University of Arkansas Medical Center
Little Rock, Ark.

REFERENCES

1. KELLING, G.: Ueber Oesophagoskopie, Gastroskopie und Kölioskopie. München med. Wchnschr. **49**: 21–24, 1902.
2. WEBER, E.: Ueber die Bedeutung der Einführung von Sauerstoff resp. Luft in die Bauchhöhle für die experimentelle und diagnostische Röntgenologie. Fortschr. a. d. Geb. d. Röntgenstrahlen **20**: 453–455, 1913.
3. STEWART, W. H., AND STEIN, A.: Roentgen Ray Study of the Abdominal Organs Following Oxygen Inflation of the Peritoneal Cavity. Am. J. Roentgenol. **6**: 533–542, November 1919.
4. ALVAREZ, W. C.: Use of CO_2 in Pneumoperitoneum. Am. J. Roentgenol. **8**: 71–72, February 1921.
5. STEIN, I. F., AND ARENS, R. A.: Iodized Oil and Pneumoperitoneum in Gynecology. A Clinical Radiological Study. Radiology **8**: 494–501, June 1927.
6. ADRIANI, J.: The Chemistry of Anesthesia. Springfield, Ill., Charles C Thomas, 1946, p. 62.
7. TESCHENDORF, W.: Über die Verwendung schnell resorbierbarer Gase in der Röntgendiagnostik. Acta radiol. **36**: 297–304, October 1951.
8. DECKER, A.: Artificial Pneumoperitoneum by Cul-de-sac Puncture; New Technic for Pelvic Pneumograms. New York State J. Med. **46**: 314–317, Feb. 1, 1946.
9. RUBIN, I. C.: Subphrenic Pneumoperitoneum Produced by Intra-uterine Insufflation of Oxygen as a Test of Patency of the Fallopian Tubes in Sterility and in Allied Gynecological Conditions. Am. J. Roentgenol. **8**: 120–128, March 1921.
10. ABRAMS, B. S., AND HUGHES, A.: Pneumography as an Aid in the Diagnosis of Gynecologic Disease. Am. J. Obst. & Gynec. **70**: 1115–1125, November 1955.
11. GRANJON, A.: La gynécographie. Presse méd. **61**: 1764–1766, Dec. 25, 1953.
12. MASON, E. E.: Pneumoperitoneum in the Management of Giant Hernia. Surgery **39**: 143–151, January 1956.
13. CARELLI, H. H.: Pneumoperitoneum. Am. J. Roentgenol. **10**: 259–279, April 1923.
14. STEIN, I. F.: Why Pneumoperitoneum? Radiology **28**: 391–398, April 1937.
15. STEIN, H. F.: Complications of Artificial Pneumoperitoneum; a Review. Am. Rev. Tuberc. **64**: 645–658, December 1951.
16. STAUFFER, H. M., DURANT, T. M., AND OPPENHEIMER, M. J.: Gas Embolism. Roentgenological Considerations, Including the Experimental Use of Carbon Dioxide as an Intracardiac Contrast Material. Radiology **66**: 686–692, May 1956.

(Pro le summario in interlingua, vider le pagina sequente)

SUMMARIO IN INTERLINGUA

Pneumographia Abdominal e Pelvic

Ha essite trovate que insufflation del gas oxydo nitrose es un salve e simple methodo pro delinear le organos abdominal e pelvic. Le methodo es etiam rapide e non require frequentemente plus que dece-cinque minutas. Le gas es absorbite rapidemente, e le examine pote esser effectuate sin hospitalisation del patiente.

Non-elucidation del natura de un processo pathologic per medio del examine routinari suffice como indication pro effectuar pneumoperitoneo diagnostic. Le presentia intraperitoneal del gas resulta in un definition de alte grados de claritate non solmente del cavitate peritoneal sed etiam del peritonealisate superficies del visceres abdominal e pelvic. Le uso combinate de un medio opac pro demonstrar le interior de un organo cave e de un gas como medio radiolucente pro delinear le contorno externe es altemente recommendabile.

Ben que etate avantiate, le presentia de diffuse o localisate peritonitis, e le presentia de un massa que replena completemente le abdomine e le pelve es frequentemente listate como indicationes contra le introduction de gas, le presente autores crede que iste restrictiones del methodo non vale quando oxydo nitrose es usate. Le autores non exclude un patiente ab le uso del methodo si ille non se trova in un condition critic. In un serie de 110 casos, illes ha incontrate nulle reactiones adverse.

Reportos de casos es includite como illustrationes.

The Radiotoxic Effects of S^{35} in Growing Cartilage

Consideration of Radioactive Sulfur (S^{35}) as a Possible Radiotherapeutic Agent in Chondrosarcomas[1]

PHILIP RUBIN, M.D., KIRKLAND C. BRACE, M.D., HAZEL GUMP, RICHARD SWARM, M.D., and J. ROBERT ANDREWS, M.D.

WITH THE AVAILABILITY of radioactive sulfate, many experiments have been conducted to enhance our biological concept of chondroitin sulfate. It has been shown that the radioactive sulfur of labeled sulfate given to rats is incorporated into chondroitin sulfate and fixed in cartilage (1, 2). It is known that differentiated tumors have a metabolic pattern similar to their tissue of origin. The uptake of S^{35} by tissue cultures of human cartilage and tumors was studied by Layton (3) to confirm the cartilaginous nature of the growths by *in vitro* studies. Observations on the uptake of sulfate in human chondrosarcoma *in vivo* appear to be limited to the two cases studied by Gottschalk (4). He found that S^{35} was retained at high levels in both primary and metastatic chondrosarcoma, with lesser amounts in the normal cartilage, bone marrow, and other tissues. His autoradiographs indicate maximum concentration in the growing portions of the chondrosarcoma and in the areas containing abundant ground substance.

Since the beta radiation of S^{35} is in the neighborhood of 50 kv, the mean range of the emitted electron will be limited to a radius of 100 μ, with a maximum range of 200 μ. As chondroitin sulfate and therefore radioactive sulfur are deposited in greatest concentrations about chondrocytes, the path of the beta rays is sufficient to include a number of cartilage cell diameters. To date, no evidence of cartilaginous destruction has been shown in the low-dose ranges in which radioactive sulfur has been used in animals. It seems essential, before one considers the use of this radioisotope therapeutically in patients with chondrosarcoma, that evidence of a selective radiotoxic effect in cartilage be demonstrated experimentally.

PROCEDURES

Experiment I: In order to determine if cartilaginous changes could be produced with sublethal doses of S^{35}, eleven litters of white Osborne Mendel suckling rats, varying in age from three days to two weeks and in weight from 8 to 25 gm., were utilized. The radioactive sulfur solution obtained from Oak Ridge was of high concentration, 72.4 mc/ml., with a low solid content of 1 mg./ml. The S^{35} was carrier-free, in the form of Na_2SO_4 in an acidified solution which was neutralized before injection. The amounts of radioactive sulfate injected ranged from a postulated toxic level to a tolerated level as follows: 2.0 mc/gm., 1.0 mc/gm., 0.5 mc/gm., 0.2 mc/gm. to 0.1 mc/gm. of body weight. Litter mates were used in each group of animals and control observations were made with stable sulfate and uninjected mates. The full amount of S^{35} injected under sterile conditions, intraperitoneally, was less than 1 c.c. in volume. Roentgenograms of the animals were made every two weeks initially and then every month. They were weighed weekly. Three animals which died were studied by radioautographs and microscopic sections.

The conclusions from these studies established that growing cartilage in a suckling rat could be markedly altered by radiosulfate. It appeared that levels above 0.5 mc/gm. were uniformly fatal in less than thirty days. Radiosulfate was tolerated, in terms of survival, at the lowest level employed, 0.1 mc/gm. A small

[1] From the Radiation Branch, National Cancer Institute, and the Department of Pathological Anatomy, Clinical Center, National Institutes of Health, Public Health Service, Department of Health, Education, and Welfare, Bethesda, Md. Accepted for publication in May 1957.

Fig. 1. A. S^{35}-injected rat (0.3 mc/gm.) at three months of age, showing the slipped tibial and femoral epiphyses and widened and dysplastic metaphyses. The vertebrae in the tail are smaller and the epiphyses irregular. B. Control animal.

group of animals receiving this low dosage have been observed for one year and have continued to live despite their severely malformed and stunted skeletons. Recently, in one of the number a soft-tissue tumor has developed in the region of the right shoulder.

Experiment II: Further studies were indicated to determine whether certain factors suggested in the preliminary experiment could be quantitated. Extension of the experiments was designed to determine the following points: (*a*) the dosage range that would affect cartilage growth without irreversibly damaging vital organs; (*b*) the effect of a fractionated injection schedule *versus* a single injection in the production of maximal changes in cartilage; (*c*) the toxic effects on other organs and whether these could be lessened by the different methods of injection described in (*b*).

Seven groups of 8 Osborne Mendel male rats were carefully selected so that the animals were of similar ages (three weeks old) and similar weight (40 gm. ± 5 gm.). Weaned rats rather than suckling rats were chosen, since each animal could be caged separately and contamination of lower-dose animals by ingestion of the excreta and carcasses of larger-dose animals could thereby be obviated. The radiosulfate was prepared as previously described and injected intraperitoneally.

The dosage range selected varied by a factor of 10 from maximum to minimum and a factor of 3 between groups.

A. Controls: Single injection of non-radioactive sodium sulfate.
B. Single injection: 0.3 mc/gm. of body weight.
C. Single injection: 0.1 mc/gm. of body weight.
D. Single injection: 0.03 mc/gm. of body weight.
E. Fractionated injection*: 0.1 mc/gm. × 3 = 0.3 mc/gm. of body weight.
F. Fractionated injection*: 0.033 mc/gm. × 3 = 0.1 mc/gm. of body weight.
G. Fractionated injection*: 0.01 mc/gm. × 3 = 0.03 mc/gm. of body weight.

All animals were weighed weekly and blood counts were performed seven days after injection and at biweekly intervals. Roentgenograms of the skeleton were taken at biweekly intervals after injection, and a group of the animals were sacrificed at

* The fractionated schedule called for two-week intervals between injections.

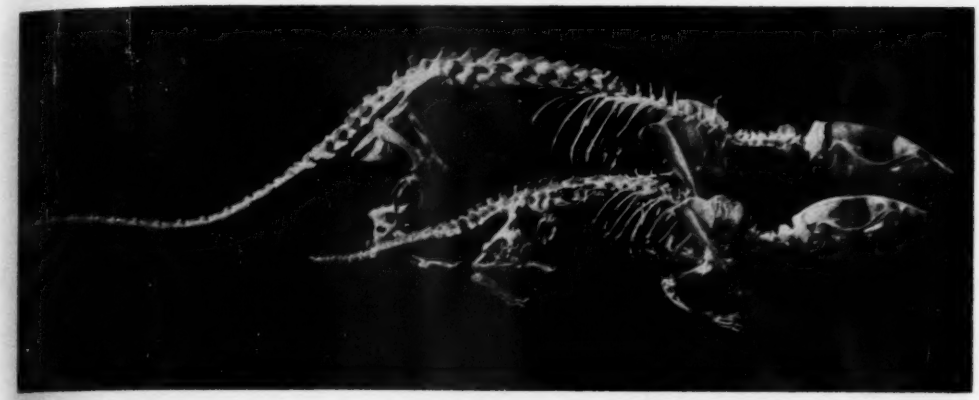


Fig. 2. Skeletons of S^{35}-injected rat (0.3 mc/gm.) and normal control at six months, to illustrate bone deformities and extreme dwarfed appearance.

similar intervals for correlative autoradiographs and microscopic examination of the tissues.

RESULTS

Cartilaginous Changes: Radiotoxic effects of S^{35} were apparent roentgenographically as early as twelve days following the initial injection. The earliest manifestation was a loss of calcification in the metaphyseal ends of the long bones. At the conclusion of one month, slipping of the humeral, tibial, and femoral epiphyses was noted. The metaphyses were widened and dysplastic. The wrists showed cupping of the metaphyses and retardation in development of the epiphyses. The vertebrae in the tail were smaller and the epiphyses were irregular. Progression of these findings was again noted at six weeks. At the end of two months, the stunting effect of S^{35} was markedly evident in the decreased length of all long bones, loss of vertebral height, and narrowed ribs and pelvis (Fig. 1). The striking cessation in growth and the altered anatomic appearance became more striking as time elapsed. At six months to one year the affected rats were extremely dwarfed, seldom exceeding the length of a one-month-old normal control (Fig. 2). The long bones showed a loss of normal modeling, with extremely irregular epiphyses and metaphyses. This correlates well with

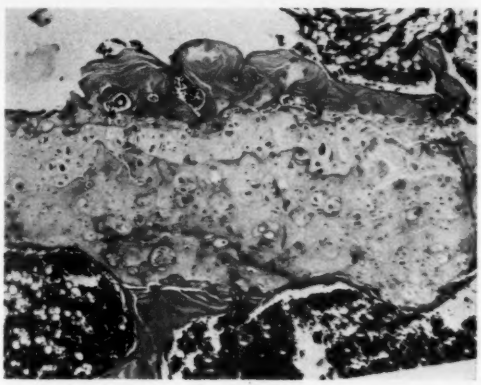


Fig. 3. Histologic section of femoral epiphyseal plate showing absence of the characteristic zoning of cartilage and the marked alteration of chondrocytes at six months after three injections of 0.1 mc/gm.

the absence of the characteristic zoning of cartilage in the epiphyseal plate and the marked vacuolization and alteration of the chondrocytes seen histologically (Fig. 3). The joints were narrowed and deformed, the ribs beaded at the cartilaginous ends, the clavicles underdeveloped, and the epiphyses of the vertebrae were ununited and irregular. The skull was the only skeletal part that appeared to have developed normally, though of smaller size than in the controls (Fig. 4).

It is seen that 0.1 mc/gm. is the minimal level required to produce a significant alteration of cartilage growth and development on the basis of roentgen evi-

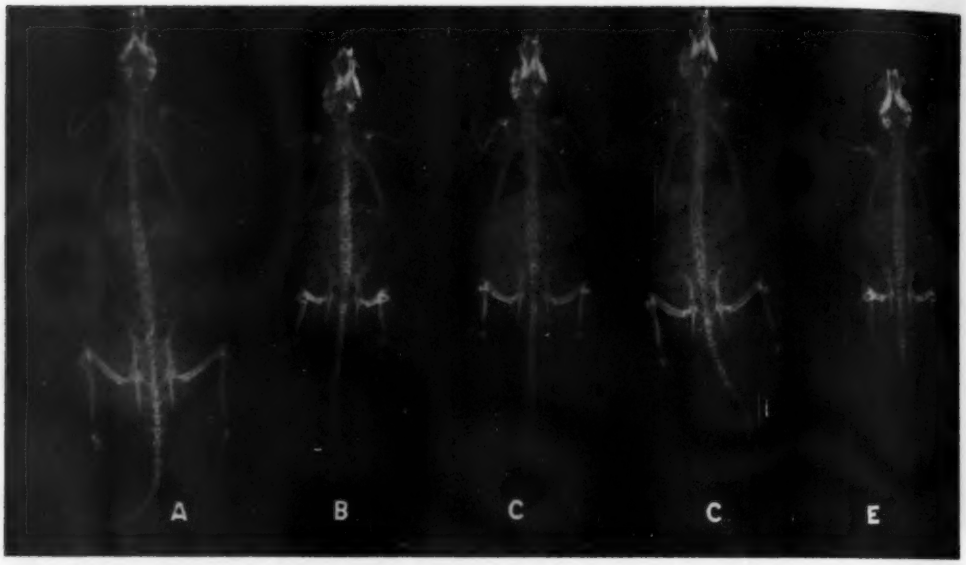


Fig. 4. A group of selected animals at six months to illustrate the various radiotoxic effects of S^{35} on cartilage growth, depending upon dosage schedule. No animals of Groups D, F and G are shown, since they were similar to the controls. The letter below each animal indicates the group in which it belongs (see p. 712).

dence. Although the lower doses have delayed bone growth and produced some microscopic alterations, these effects have been temporary, and regeneration of cartilage has occurred. Complete discussion of these histologic changes will be presented in another report (5).

Fractionated Injection versus Single Injection Schedules: In an effort to relate the severity of the cartilaginous changes (Fig. 3) to the amount of S^{35} administered in single doses and multiple doses, the lengths of several of the long bones have been measured from the whole-body films. The results of these measurements are typified by the graph of tibial lengths shown in Figure 5. The maximum dose (0.3 mc/gm. of body weight) utilized in both the single and divided dose groups provides the most striking alterations in long bone growth. If a choice must be made between the single and divided dose, it is apparent that the divided dose of 0.3 mc/gm. is more effective in destroying cartilage and arresting bone growth. The single dose of 0.1 mc appears to provide an intermediate effect, but this is a mean of all the animals measured. Actually, the effect of this single dose appears to be an all-or-none phenomenon, with some animals in the group showing practically no effect on long bone growth while others are markedly dwarfed (compare two C animals in Fig. 4). In contrast, the divided dose with a total of 0.1 mc per gram shows considerably less effect. The smaller doses, both single and divided, produced some delay in bone growth, which proved to be only temporary. Although no significant changes from normal controls could be detected on films, microscopic evidence of alteration of the cartilage of the epiphyseal plate was seen.

Toxicity: The only deaths that occurred in this study were at the 0.3 mc per gram level. Two animals in Group B died in the first two weeks following administration of the S^{35}. Both of these animals showed severe depression of the white count prior to death. The lymphocytes, which are the most radiosensitive component, accounted for the alterations in the white blood count (Fig. 6) on the basis of differential counting. An initial depres-

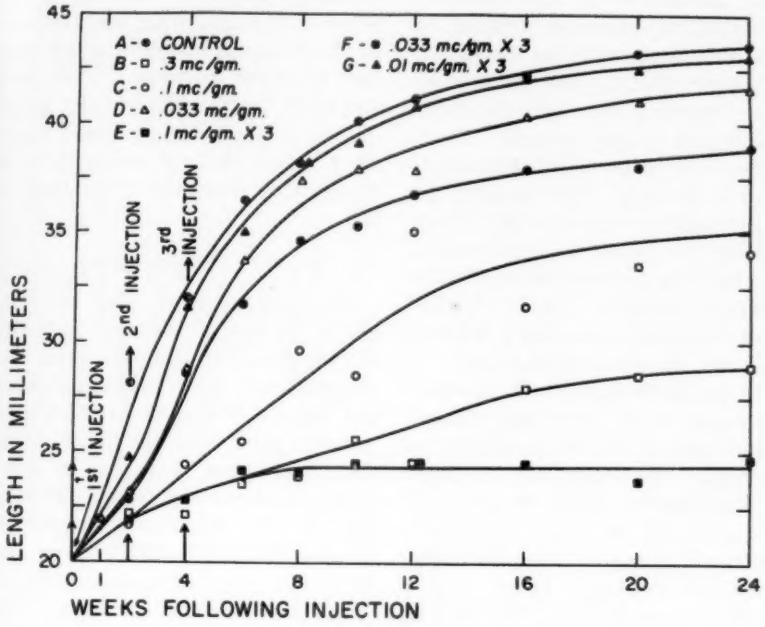


Fig. 5. Effect of S^{35} injections on length of tibia of rats.

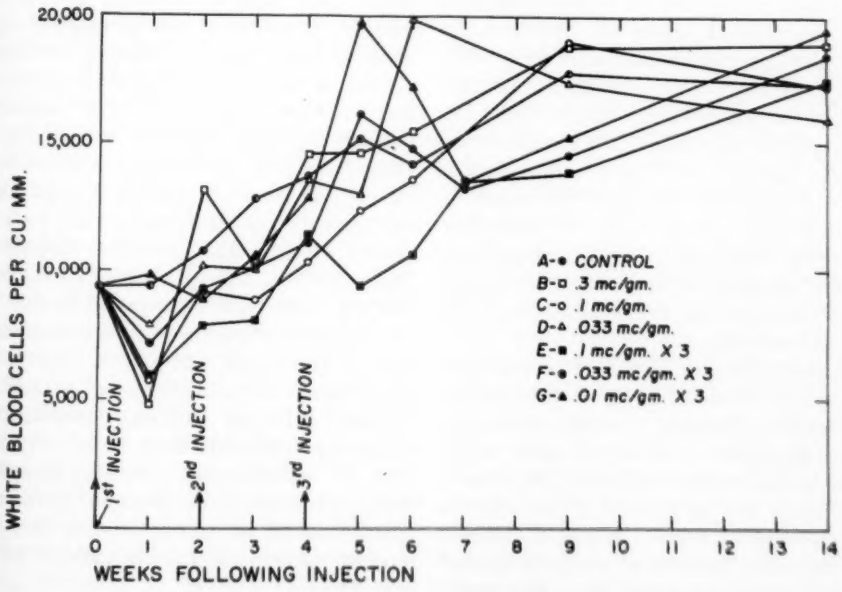


Fig. 6. Effect of S^{35} injections on white blood count of rats.

sion of lymphocytes was observed, proportional to the amount of S^{35} administered. After the single injection, a typical rebound was observed, with an extremely high lymphocyte count, while in animals receiving the divided dose the decreased lymphocyte count was prolonged. Eventually, however, the white count returned to normal in all groups. The neutrophils and eosinophils did not show any significant changes during the period of observation. Hemoglobin remained within normal limits.

Bone marrow aplasia was established as a cause of death in the Group B animals described in the previous paragraph. In all the other animals studied at autopsy, the bone marrow was active and normal, even when it was in direct proximity to severely altered and damaged cartilage (Fig. 3). The transit of large amounts of radioactive material through the kidney in a concentrated form produced no recognizable histologic changes. Only a small amount of S^{35} is excreted *via* the gastrointestinal mucosa (6), and no evidence of ulceration or necrosis has been noted.

A number of sources (7, 8) indicate that skin is the critical organ for S^{35}, but the present studies have failed to verify this. Some S^{35} sulfate is deposited in the ground substance of connective tissues but, to date, changes in cartilage have far exceeded in quality and degree any changes in the skin or connective tissues. No loss of hair, ulceration, or atrophy of skin has been noted. The possibility and pattern of neoplastic disease following S^{35} cannot be ascertained from the studies to date. Testicular atrophy was noted.

Since body weight (Fig. 7) is a function of the systemic effect of S^{35} and its effect on the length of bones, it is somewhat difficult to interpret. There is little argument as to the marked effect of the highest dose in both the single and divided injection schedules. These animals showed about the same amount of weight loss, but the onset was more rapid after the single injection. The single dose of 0.1 mc per gram has been commented upon previously because it represents a mean between the animals severely affected and those remaining relatively unaffected. The only other animals showing some effect are those of the F group, which weighed only slightly less than the normals. The similarity of the body weight plots to the graphs of the growth rate of the long bones suggests that they reflect skeletal retardation as well as the general systemic irradiation effects of S^{35}.

DISCUSSION

Extrapolation of the present animal study to the problem of radiotherapeusis of chondrosarcoma in man is mainly speculative. Any internally administered isotope, to be of value in affecting a specific tumor, must be tolerated systemically, selectively concentrated in the desired tissue, and produce irreversible radiotoxic effects. In considering the possible clinical usefulness of S^{35} sulfate, it is appropriate to analyze the following aspects:

(1) *The Selective Radiolytic Effect of S^{35} in Growing Cartilage:* It has been demonstrated that S^{35}, administered in large doses, can arrest cartilage growth completely, as noted in the present roentgenographic and histopathologic studies. It would appear that a chondrosarcoma, if it is to respond favorably to S^{35}, should be similar in many respects to growing cartilage, that is, with a ground substance rich in chondroitin sulfate if high concentrations of this isotope are to be anticipated. The highly cellular variety with little matrix will probably pick up less sulfate, although it is possible that relatively large amounts may be concentrated due to the rapid rate of cell growth, independent of its elaboration of ground substance. Mature cartilage neoplasms undergoing calcification or necrosis probably will be unaffected. Tissue assays and radioautographs of human chondrosarcomas based on tracer studies *in vivo* (4) and *in vitro* (3) add some validity to these statements.

(2) *The Systemic Radiotoxic Effects of S^{35} Sulfate:* The possible sites of radiotoxicity include: bone marrow, gastro-

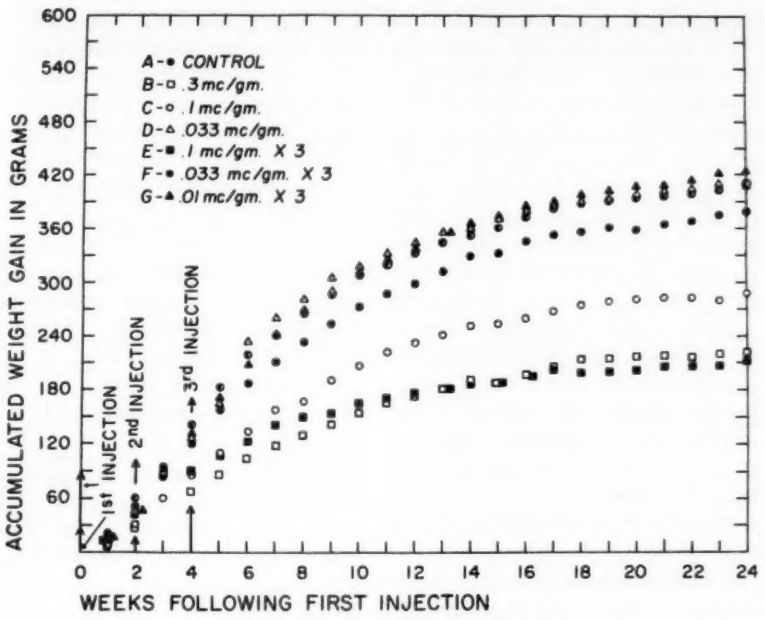


Fig. 7. Effect of S^{35} injections on weight gain of rats.

intestinal tract, kidney, normal cartilage, lens, skin, and gonads. Before employing large amounts of radiosulfur clinically, it is essential to establish experimentally the effects of such high doses in the aforementioned organs. In the studies reported here death was due to bone marrow depression and depletion following exceedingly high doses, *i.e.*, LD 25/30 for 0.3 mc/gm. body weight in a weaned rat. Fractionating this amount tended to decrease the untoward effect. The clearance of most of the radiosulfate *via* the glomeruli resulted in no microscopic renal changes. S^{35} excretion *via* the feces was less than 1 per cent and no significant pathologic changes were noted. The liver and brain, which received about the same amount of irradiation as the kidney, also tolerated the dose without reaction. Skin and cornea, despite the long biologic half-lives reported (9),[2] were free of histologic damage. Mature cartilage has a low concentration of chondroitin sulfate in its ground substance and therefore takes up much less S^{35} than growing cartilage. In addition, it is more resistant to equivalent doses of irradiation. This was confirmed in adult mice injected with high doses of radiosulfate (10). Evidence of testicular atrophy was noted but the gonads are not essential to survival. No vascular damage or aneurysmal dilatation has been found.

(3) *Significant Localization of S^{35} in Chondrosarcoma:* As in thyroid carcinomas in which I^{131} is employed, the favorable situations are those in which active elaboration of extracellular material is present. Thus, the concentration of I^{131} in colloid material may be compared to that of S^{35} in the chondroitin sulfate in cartilage. Whether toxicity to chondrosarcoma can occur before unfavorable systemic effects depends on the selective uptake of S^{35}, the rate of its biologic turnover in the neoplasm, and the radiosensitivity of the tumor. The dosage in rep of S^{35} to different sites is less dependent on the uptake and more on the turnover in tissue, the

[2] Chondroitin sulfuric acid: in skin of rat, about ten days; in cornea of rat, about thirty days.

so-called biologic half-life. In most vital organs, this is of the order of twelve to twenty-four hours (11). Various estimates in bone marrow, based on animal studies (12), range from eighteen to seventy two hours. Growing cartilage has a slower turnover, seventeen days for radiosulfate as chondroitin sulfate. In those tissues with longer biologic half-lives, the tissue is generally more resistant to irradiation than growing cartilage, or the initial uptake (10) is less. Most of this information is based upon animal studies, and the need for similar work in man is apparent.

It is for this reason that an elaborate tracer study, requiring multiple serial biopsies over a period of a month is now in progress. The data collected must be critically evaluated in each patient afflicted with chondrosarcoma who is considered as a possible candidate for such an approach. If tracer tissue assays show favorable differential ratios of S^{35} between the neoplastic and other tissues, direct translation of our data for growing cartilage suggests that radiosulfur may produce a radiotoxic effect on the tumor similar to that on growing cartilage and be tolerated by the patient. The proximity of the toxic and postulated therapeutic doses necessarily limits initial attempts to those patients with a short life expectancy, in which the disease is advanced, and for whom conventional treatment has nothing to offer.

SUMMARY

1. The minimal dose of S^{35} required to arrest cartilage growth in the weaned rat was found to be 0.1 mc/gm. of body weight. The changes were severe, resulting in an irreversible alteration and destruction of the cartilage in the metaphyses and epiphyses. Reversible changes were noted with the lower doses employed.

2. When a dose of 0.1 mc/gm. was administered three times at biweekly intervals to a total amount of 0.3 mc/gm. level, there resulted more profound changes in cartilage growth than when 0.3 mc/gm. was given in a single injection.

3. The maximum tolerated levels compatible with survival were in the neighborhood of 0.3 mc/gm. as a single injection, since this has an LD 25/30. When this same dose was achieved by a fractionated schedule of 0.1 mc/gm. of body weight $\times$ 3 it was better tolerated and no deaths occurred.

4. A fractionated dosage schedule at the 0.3 mc/gm. level was more effective in arresting and altering cartilage growth and less toxic systemically than a single injection at this same level.

5. The possible use of S^{35} in patients with chondrosarcoma is discussed.

ACKNOWLEDGMENT: The authors wish to express their appreciation to Dr. Raymond G. Gottschalk for his participation and interest in Experiment I; also to Mr. Joseph Morel, R.T., for working out the radiographic technics for these animals.

Strong Memorial Hospital
260 Crittenden Blvd.
Rochester 20, N. Y.

REFERENCES

1. DZIEWIATKOWSKI, D. D., BENESCH, R. E., AND BENESCH, R.: On the Possible Utilization of Sulfate Sulfur by the Suckling Rat for Synthesis of Chondroitin Sulfate as Indicated by the Use of Radioactive Sulfur. J. Biol. Chem. **178**: 931–938, April 1949.

2. DZIEWIATKOWSKI, D. D.: Radioautographic Visualization of Sulfur-35 Disposition in the Articular Cartilage and Bone of Suckling Rats Following Injection of Labeled Sodium Sulfate. J. Exper. Med. **93**: 451–458, May 1951.

3. LAYTON, L. L.: Labeled Inorganic Sulfate in the Diagnosis of Cartilaginous Tumors and Their Metastases. Cancer **2**: 1089–1092, November 1949.

4. GOTTSCHALK, R. G., AND ALLEN, H. C., JR.: Uptake of Radioactive Sulfur by Chondrosarcomas in Man. Proc. Soc. Exper. Biol. & Med. **80**: 334–339, June 1952.

5. SWARM, R., RUBIN, P., AND BRACE, K. C.: Selective Radiation Injury to Cartilage with Radioactive Sulfate. (To be published as an abstract in Am. J. Path.)

6. WALSER, M., REID, A. F., AND SELDIN, D. W.: A Method of Counting Radiosulfur in Liquid Samples, and Its Application to the Determination of S^{35} Excretion Following Injection of $S^{35}O_4$. Arch. Biochem. **45**: 91–96, July 1953.

7. DZIEWIATKOWSKI, D. D.: Conversion of Sulfide Sulfur to Cystine Sulfur in the Rat, with the Use of Radioactive Sulfur. J. Biol. Chem. **164**: 165–171, July 1946.

8. RECOMMENDATIONS OF THE INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION. Revised December 1954. Brit. J. Radiol. Supplement 6. London, British Institute of Radiology, 1955.

9. BOSTRÖM, H.: Personal communication.

10. GOTTSCHALK, R. G.: Personal communication.

11. DZIEWIATKOWSKI, D. D.: Rate of Excretion of

Radioactive Sulfur and Its Concentration in Some Tissues of the Rat after Intraperitoneal Administration of Labeled Sodium Sulfate. J. Biol. Chem. **178**: 197–202, March 1949.

12. ODELL, T. T., JR., TAUSCHE, F. G., AND GUDE, W. D.: Uptake of Radioactive Sulfate by Elements of the Blood and the Bone Marrow of Rats. Am. J. Physiol. **180**: 491–494, March 1955.

SUMMARIO IN INTERLINGUA

Le Effectos Radiotoxic De S^{35} In Cartilagine Crescente: Consideration De S^{35} Como Possibile Agente Radiotherapeutic In Chondrosarcomas

Es cognoscite que le sulfure radioactive de sulfatos marcate e administrate a rattos es incorporate in sulfato chondroitinic e fixate in cartilagine. Iste facto suggere le possibilitate de utilisar le isotopo in le therapia de chondrosarcoma human. Tamen, un selective effecto radiotoxic in cartilagine debe esser demonstrate ante que definite conclusiones relative a tal applicationes clinic pote esser stipulate.

Es reportate experimentos con rattos. Esseva trovate que le dose minimal de S^{35} requirite pro arrestar le crescentia de cartilagine in rattos dislactate es 0,1 millicurie per gramma de peso corporee. Le alterationes esseva sever, resultante in effectos irreversibile con destruction de cartilagine in meta- e epiphyses. Quando iste dose esseva administrate tres vices con intervallos de duo septimanas, le alterationes in le crescentia de cartilagine esseva plus profunde que quando le mesme total de 0,3 millicuries per gramma de peso corporee esseva administrate in un sol injection.

Le maximos de dosage compatibile con superviventia esseva vicin a 0,3 millicuries per gramma de peso corporee. Iste dose administrate como un sol injection effectuava un mortalitate de 25 ex 30. Quando le mesme total esseva administrate in fractiones (i.e. 3 vices 0,1 millicuries per gramma), le toleration esseva melior, e nulle mortes occurreva. In plus, le administration in fractiones esseva plus efficace in arrestar e alterar le crescentia de cartilagine e minus toxic systemicamente.

Extrapolationes ab iste observationes al problema de chondrosarcoma in humanos es primarimente de character speculative.

Malignant Neoplasm of the Gallbladder: Roentgenological Diagnosis[1]

FLEMING McCONNELL, M.D.[1]

THE DIAGNOSIS of primary neoplasm of the gallbladder is a clinical problem the preoperative solution of which may be dependent on a thorough roentgenologic study. Because of the importance of this method of examination, a review of available roentgenograms has been undertaken in a search for possible distinctive and diagnostic characteristics.

Films were available in 33 cases seen at the Massachusetts General Hospital in which primary cancer of the gallbladder had been histologically proved. Cases in which the tumor was of undetermined origin were excluded. Carcinoma of the gallbladder is not a common disease, the postmortem incidence being approximately 0.4 per cent (6). At this hospital, over the period covered by the present study, carcinoma of the pancreas was diagnosed four times more frequently than carcinoma of the gallbladder.

The gross pathological picture of carcinoma of the gallbladder is conditioned by the anatomy of the organ and of the lymphatic drainage (2, 4). The gallbladder is a subserosal sac which lies along the inferior margin of the liver. Its posterior limit, as it joins the cystic duct, is closely related to the superior and lateral aspects of the upper flexure of the duodenal loop. Its anterior limit, the fundus, frequently is at the anterior margin of the liver, and may extend beyond this to be in contact with the anterior abdominal wall. The gallbladder generally lies lateral to the pyloric antrum and medial to the hepatic flexure. Its position, however, is quite variable, depending on such factors as the level and inclination of the inferior surface of the liver and the presence or absence of a gallbladder mesentery. The lymphatics of the inferior surface of the liver drain toward the lymph nodes of the porta hepatis, and the lymphatics of the gallbladder join these. Portal nodes also receive lymphatics from the peripancreatic and mesenteric regions. In addition there is a rich lymphatic and venous anastomosis between the gallbladder and the adjacent liver parenchyma.

The histology of primary cancer of the gallbladder has been reviewed amply in the literature (11). The tumor is usually an adenocarcinoma but occasionally is of the squamous variety; sarcomas have been reported. Whatever the type, it is commonly associated with cholelithiasis, and almost invariably with cholecystitis. The carcinoma may form a bulky mass within or around the gallbladder, or it may provoke a scirrhous reaction resulting in a small fibrosed and contracted gallbladder. Direct spread to the liver occurs early. Local metastases to the porta hepatis and liver are frequent, and metastatic involvement of peripancreatic and mesenteric lymph nodes is not unusual. Peritoneal dissemination occurs occasionally, but distant metastases in lung or bone are uncommon. Carcinoma metastasizing to the gallbladder is extremely rare, except as part of a general peritoneal carcinomatosis. In the present series there were 28 adenocarcinomas and undifferentiated carcinomas, 3 squamous-cell carcinomas, 1 adenoacanthoma, and 1 sarcoma.

The clinical picture associated with cholecystic cancer is well established (2, 6, 11). The patient is generally a female with moderately acute symptoms (the most common being upper abdominal pain and jaundice) of short duration. Occasionally these have been superimposed on chronic biliary symptoms of much longer duration. In the group presented, 28 of the 33

[1] From the Department of Radiology, Massachusetts General Hospital, Boston, Mass. Accepted for publication in July 1957.

patients were women. The average age at admission to the hospital was sixty-six years; the youngest patient was forty-eight. The average duration of symptoms was less than six months. Twenty-seven of the 33 patients complained of pain, and in 18 there was jaundice, which was usually the immediate cause for seeking medical advice. Unusual presenting symptoms were the feeling of a mass, vomiting, ulceration of a cholecystostomy scar, and fever.

With the exception of jaundice, the most common physical sign was a mass in the right upper quadrant, present or suspected in 22 of the 33 patients. An enlarged liver was felt in 15, and gastrointestinal bleeding occurred in 9, but this was never a primary complaint.

The diagnoses most frequently suggested by the referring clinician were carcinoma of the head of the pancreas, common duct stone, and metastatic carcinoma in the liver. In only 3 instances was primary gallbladder carcinoma seriously considered.

To the radiologist, then, comes the diagnostic problem of an elderly woman with jaundice, pain, a right upper quadrant mass, and occasionally, also, gastrointestinal bleeding.

ROENTGEN EXAMINATIONS

Four variations of radiologic study of the gallbladder may be employed.

1. *Plain roentgenograms of the abdomen* were available in 29 cases. In 7 of these a mass, usually continuous with the liver shadow and forming a hemispherical bulge below the anterior liver margin, was seen outlined by colonic gas. Anteroposterior projections with the patient supine were more satisfactory than others, probably because that position favors accumulation of air in the transverse colon. Obliteration of the liver margin adjacent to the mass was sometimes noted, and occasionally the mass was indistinguishable from a large right lobe of the liver. In two instances the tumor, being very large and extending down to the level of the pelvic brim, was outlined (on its lateral aspect) by air in the ascending colon.

Fig. 1. Lateral and inferior displacement of stones in the fundus by a tumor in the body of the gallbladder. The mass also causes a pressure defect on the lateral aspect of the pyloric antrum.

Tumors which are primarily in the porta or are intrahepatic are not detectable on the plain films. Actually, in 16 cases masses considerably larger than the gallbladder itself were present, and in detecting these the palpating hand was more accurate than the plain abdominal film. In 9 instances calcification due to gallstones was seen. In 1 such case the stones appeared to lie considerably more inferior and lateral than usual, this displacement being caused by tumor in the proximal portion of the gallbladder (Fig. 1).

The presence of air—a local, irregular accumulation in the center of the tumor mass (not in the biliary tree)—due to fistulous connection with the intestinal tract has been considered by some investigators (1) as almost diagnostic of carcinoma of the gallbladder. Two such cases were found in the present group, one fistula arising from the transverse colon, and the other from the duodenum.

Enlargement of the spleen due to pressure of tumor on the portal vein in the porta hepatis might be anticipated. This, however, was found only once.

Fig. 2. Carcinomatous enlargement of the gallbladder producing a concave defect in the superior aspect of the proximal transverse colon.

2. The gallbladder lies along the inferior surface of the liver with the fundus close to the anterior abdominal wall and in close relation to the splenic flexure and proximal transverse colon. An enlarging gallbladder might thus impinge on the superior surface of the transverse colon, producing a recognizable displacement or defect, but this was an unusual finding.

Contrast enema studies were performed in 14 patients, in 4 of whom displacement of the hepatic flexure or proximal transverse colon was seen; in only 1, however, was a definite concave pressure defect identifiable. This defect had the appearance of a spherical mass indenting the superior surface of the colon (Fig. 2). It is apparent, therefore, that identification of the gallbladder tumor is less satisfactory on a barium study of the colon than on the plain anteroposterior film of the abdomen.

3. It might be expected that *contrast studies of the gallbladder* would be of some value in demonstrating early carcinoma as a filling defect in that organ. Two text books of radiology (5, 9) present illustrations of satisfactory contrast filling of a gallbladder with a moderately large filling defect stated to be due to a carcinoma. This must, however, be an extremely rare occurrence, as only one such possible case was found in the periodical literature (10). Nonvisualization of the gallbladder is the usual reported finding (7), probably due to the presence of associated chronic cholecystitis and/or cholelithiasis, which are almost invariable accompaniments of cancer.

In only 2 of the 12 cases in the present series in which contrast studies were attempted, was the gallbladder opacified. In both, although concentration of the contrast substance was extremely poor, it was sufficient to permit identification of nonopaque stones; no filling defect suggestive of a tumor was visible. In both cases the tumor was found to be inoperable because of invasion of the liver.

4. *Examination of the upper gastrointestinal tract* was performed in 27 cases. Displacement of the stomach and duodenum to the left and inferiorly by pressure from an enlarged liver was a common finding. In addition, in 18 instances a significant local pressure defect due to primary tumor in the gallbladder or its local metastases was seen. The nature of the local defect varied with the relation of the gallbladder and porta hepatis to the stomach and duodenal loop and with the growth pattern of the individual tumor.

The infiltrating scirrhous cancer may leave a scarred and shrunken gallbladder and may invade the porta hepatis, obstructing its ducts without producing a significant mass. These tumors cause no pressure defect in the gastrointestinal tract. On the other hand, a carcinoma may form a large mass within or surrounding the gallbladder without gross spread to the porta. These masses frequently press on the pyloric antrum and extend posteriorly to encroach on the anterior aspect of the descending duodenum.

A primary mass with this type of defect was found in 11 cases. In all, pressure on the antrum was present: in some, it manifested itself as a displacement of the antrum to the left; in others, as a pressure defect on

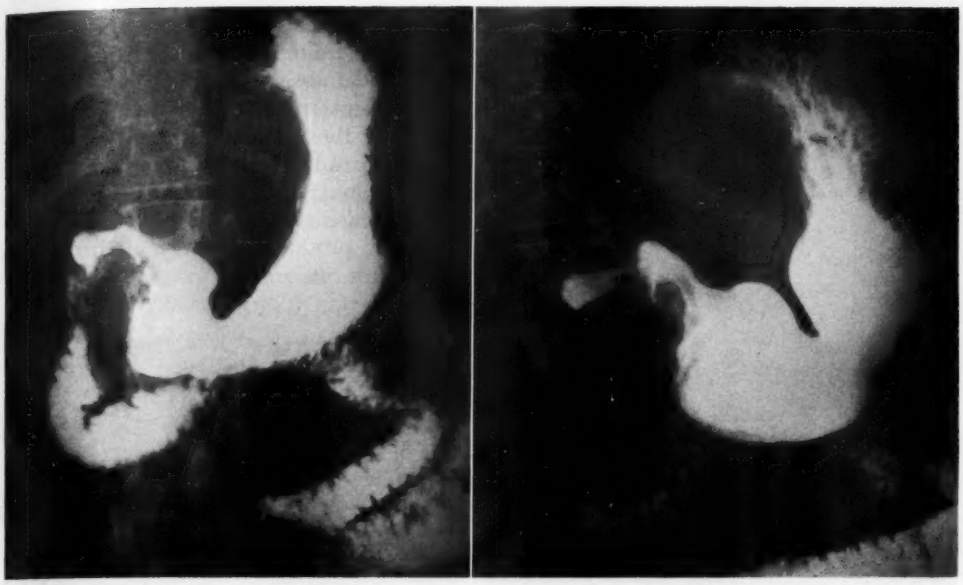


Fig. 3. Pressure defect on greater curvature of the pyloric antrum and on the anterior aspect of the descending duodenum caused by a large carcinomatous mass in the gallbladder.

the greater curvature of the antrum, usually its anterior aspect (Fig. 3); or at times as a distinct tumor invasion of the antrum on its greater curvature aspect. (Pressure here may eventually be sufficient to cause complete gastric obstruction.) Pressure on the pyloric antrum has been noted as a significant finding in gallbladder cancer (3, 8). A left anterior oblique view of the distal stomach is often helpful in determining whether the pressure is predominantly anterior or posterior, and this is of considerable value in distinguishing growths arising in the gallbladder from those arising in the head of the pancreas. With further extension of the tumor posteriorly there is occasional impingement on the upper portion of the right ureter, causing a right hydronephrosis.

Metastatic spread of the cancer to the porta hepatis is manifested by a mass in the porta which is often found to cause compression of the upper portion of the duodenal loop and adjacent antrum, usually appearing as a non-specific, fixed narrowing of the upper flexure (Fig. 4). Occasionally a distinct extrinsic pressure defect is seen, with the associated mass apparently located lateral and superior to the upper portion of the duodenal loop. (In 1 case, the pressure defect was on the posterior aspect of the flexure.) Deformity of the duodenal cap at times may be indistinguishable from scarring due to old peptic ulcer.

In 2 cases, esophageal varices, the result of compression of the portal vein by tumor in the porta, were noted. In 1 of these the spleen was enlarged.

In 3 patients, the appearance was indistinguishable from a tumor in the head of the pancreas. Two of these showed widening of the duodenal loop caused by pressure from a large primary gallbladder mass with medial displacement of the antrum and lateral displacement of the descending duodenum. The other exhibited a pressure defect on the posterior aspect of the pyloric antrum due to a metastatic mass involving the lymph nodes along the superior margin of the pancreas.

Though of the 4 roentgenologic procedures, examination of the upper gastrointestinal tract proved to be the most accurate diagnostic method in detecting tumors, it failed to show significant ab-

Fig. 4. Fixed narrowing of the upper duodenal flexure. Deformity of this type is usually caused by pressure from a mass in the porta hepatis.

normality in the presence of a cicatrizing tumor or, in several instances, of a mass in the porta hepatis.

In only 2 cases were distant metastases found. Small densities in the lungs were noted in both patients, and 1 had, in addition, osteoblastic metastatic deposits in the bones of the pelvis, skull, and lumbar spine (Fig. 5). Postmortem examination in the latter case confirmed these findings.

DIFFERENTIAL DIAGNOSIS

Roentgenologically, several conditions may be confused with cancer of the gallbladder. The most frequent is carcinoma of the head of the pancreas. Deformities caused by the latter are of a fairly constant nature, with pressure on the posterior aspect of the pyloric antrum, on the inferior aspect of the duodenal cap, and on the medial aspect of the descending duodenum. In contrast, pressure from a gallbladder tumor is usually visible on the greater curvature aspect of the pylorus, on the superior aspect of the duodenal cap, and on the anterior aspect of the descending duodenum.

Differentiation of neoplasm from hydrops of the gallbladder is, as a rule, impossible, and indeed carcinoma of the gallbladder may manifest itself as a hydrops. In one case studied, volvulus of the gallbladder produced a mass indistinguishable from tumor.

Fig. 5. Osteoblastic metastatic disease from an obscure adenocarcinoma of the gallbladder.

SUMMARY AND CONCLUSIONS

The roentgen findings in 33 cases of proved cancer of the gallbladder seen at the Massachusetts General Hospital have been reviewed. Of the four methods of radiologic study employed, *examination of the upper gastrointestinal tract* furnished the most valuable information. A distinct deformity of the stomach or duodenum caused by the gallbladder tumor was demonstrated in 18 cases. This deformity was usually due to a primary gallbladder mass, but occasionally was caused by a mass in the porta hepatis. In 29 *plain abdominal films* a mass was seen in 7 instances. In only 1 of 14 *barium examina-*

tions of the colon was there a pressure defect on the colon due to a gallbladder mass; *contrast studies of the gallbladder* in 12 cases merely made evident stones or nonfunction of the gallbladder.

The most frequent and confusing conditions requiring differentiation were carcinoma of the head of the pancreas and hydrops of the gallbladder.

The diagnosis of carcinoma of the gallbladder is a difficult problem, both clinically and roentgenologically. In the majority of cases, however, roentgenologic abnormalities which seem to be fairly typical may be present and recognized, often leading to a correct diagnosis.

Massachusetts General Hospital
Boston 14, Mass.

REFERENCES

1. ARMINSKI, T. C.: Primary Carcinoma of the Gallbladder. A Collective Review with the Addition of Twenty-Five Cases from the Grace Hospital, Detroit, Michigan. Cancer **2**: 379–398, May 1949.

2. BOCKUS, H. L., ET AL.: Gastro-Enterology. Vol. III. Philadelphia and London, W. B. Saunders Co., 1946, pp. 424–432.

3. BUTLER, P. F., AND RITVO, M.: Extra-Bowel Pathology. Am. J. Roentgenol. **25**: 474–481, April 1931.

4. CUNNINGHAM, D. J.: Text-book of Anatomy. New York, Oxford University Press, 8th ed., 1943.

5. FELDMAN, M.: Clinical Roentgenology of the Digestive Tract. Baltimore, Williams & Wilkins Co., 2d ed., 1945, p. 619.

6. JONES, C. J.: Carcinoma of the Gallbladder. A Clinical and Pathological Analysis of Fifty Cases. Ann. Surg. **132**: 110–120, July 1950.

7. KIRKLIN, B. R.: Cholecystographic Diagnosis of Neoplasms of the Gallbladder. Am. J. Roentgenol. **29**: 8–16, January 1933.

8. OCHSNER, H. C.: The Roentgenologic Diagnosis of Periduodenal and Extraduodenal Lesions. Am. J. Roentgenol. **45**: 718–723, May 1941.

9. SCHINZ, H. R., ET AL.: Roentgen-Diagnostics. First American edition (based on 5th German edition), edited by J. T. Case. New York, Grune & Stratton, Inc., Vol. 4, 1954, pp. 3714–3715.

10. TATERKA, H.: Cholezystographische Untersuchungen mittels "Decholindehnung" und "Eigelbentleerung." Röntgenpraxis **3**: 721–731, Aug. 15, 1931.

11. VADHEIM, J. L., GRAY, H. K., AND DOCKERTY, M. B.: Carcinoma of the Gallbladder. A Clinical and Pathologic Study. Am. J. Surg. **63**: 173–180, February 1944.

SUMMARIO IN INTERLINGUA

Neoplasma Maligne Del Vesica Biliari: Diagnose Roentgenologic

Es presentate un revista del constatationes roentgenologic in 33 casos de provate cancere del vesica biliari. Un del quatro methodos de studio radiologic empleate —examine del canal gastrointestinal superior—forniva le plus utile information. Un distincte deformitate del stomacho o del duodeno causate per le tumor del vesica biliari esseva demonstrate in 18 casos. Iste deformitate esseva generalmente causate per un massa primari in le vesica biliari, sed in certe casos etiam un massa in le porta hepatic esseva responsabile. Inter 29 simple radiogrammas abdominal, 7 revelava le presentia de un massa. Solmente 2 ex 14 examines a barium monstrava un definite defecto de pression in le colon causate per un massa in le vesica biliari. Studios a contrasto in le vesica biliari effectuate in 12 casos revelava solmente le presentia de calculos o le stato de dysfunction del vesica.

Le plus frequente causas de confusion e del necessitate de differentiation esseva carcinoma del capite pancreatic e hydropisia del vesica biliari.

Le diagnose de carcinoma del vesica biliari es un problema difficile, tanto clinicacomo etiam roentgenologicamente. Tamen, in le majoritate del casos, anormalitates roentgenologic de character apparentemente satis typic es presente e pote esser recognoscite, e isto resulta frequentemente in un diagnose correcte.

Agenesis of Lumbosacral Vertebrae

A Report of Two Cases in Living Infants[1]

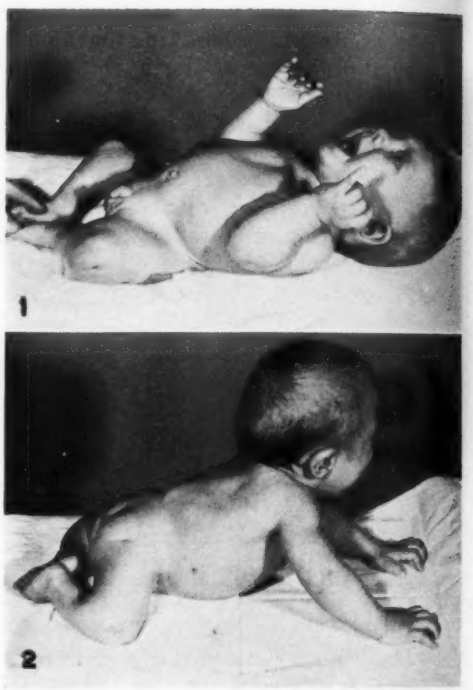
EVERETT L. PIRKEY, M.D., and JACK H. PURCELL, M.D.

CONGENITAL anomalies of the spine are common, but the majority are of no clinical significance (1). On the other hand, spine defects may be so severe, or associated with such other abnormalities, that stillbirth or death in neonatal life results (2). Complete absence of the lumbar and sacral vertebrae in an infant one year of age, as in the first of the 2 cases to be reported here, is indeed rare, no reference to such an occurrence having been found in the radiological literature. Review of our teaching files revealed a similar case, but with death in the neonatal period.

CASE REPORTS

CASE I (Figs. 1–3): L. A. G., a male infant of nine months, was admitted to Kosair Crippled Children Hospital in December 1955, with a history of low back deformity and inability to use the lower extremities since birth. Passive incontinence of bladder and bowel dated from the day after delivery, with infrequent constipation, relieved by pressure over the sacral region. No difficulty had been encountered at delivery and labor was normal. The mother denied injury, illness, and any skin eruption bearing a possible resemblance to measles during pregnancy. She had three normal children and gave no history of abortion or pelvic disease. An attempt to determine the occurrence of possible skeletal defects in relatives was noninformative.

The child was well nourished, weighing 20 pounds at nine months. The head was of normal size and the anterior fontanel was open and of normal firmness to pressure. Roentgenograms of the skull were normal, as were the thorax and its contents. The lumbosacral region was devoid of palpable osseous structures, except for a gibbus at the level of T-12. Maintenance of an upright sitting position was not possible, but balance was attempted by the infant, at which time visible evidence of contraction of abdominal and lower back musculature was confirmed by palpation. The scrotal contents and penis were normal. Abdominal palpation was negative.



Figs. 1 and 2. Case I. Photographs of the patient at nine months. Fig. 1 shows the decrease in the size of the abdomen, caudad-cephalad. The abdominal muscles and genitals are normal. Fig. 2 shows the gibbus at T-12, shortening of the lumbosacral region, and flexion of the hips and knees.

The entire lower extremities were underdeveloped, being only half normal size, with the hips fixed in abduction and the knees in flexion. Webbing of the skin over these joints was also noted. The feet were clubbed. Both extremities were areflexive and there was no physical evidence of muscular development below the hips. No sensation in the lower extremities had been noted until one month prior to examination.

Urinalysis and a complete blood study were normal. Tests for syphilis were negative. Spinal tap was not performed.

Significant roentgen findings are limited to the back and lower extremities. The spine ended

[1] From the Departments of Radiology of the Kosair Crippled Children Hospital, the Louisville General Hospital, and the University of Louisville School of Medicine, Louisville, Ky. Illustrations by the Department of Visual Education, University of Louisville School of Medicine.

Accepted for publication in July 1957.

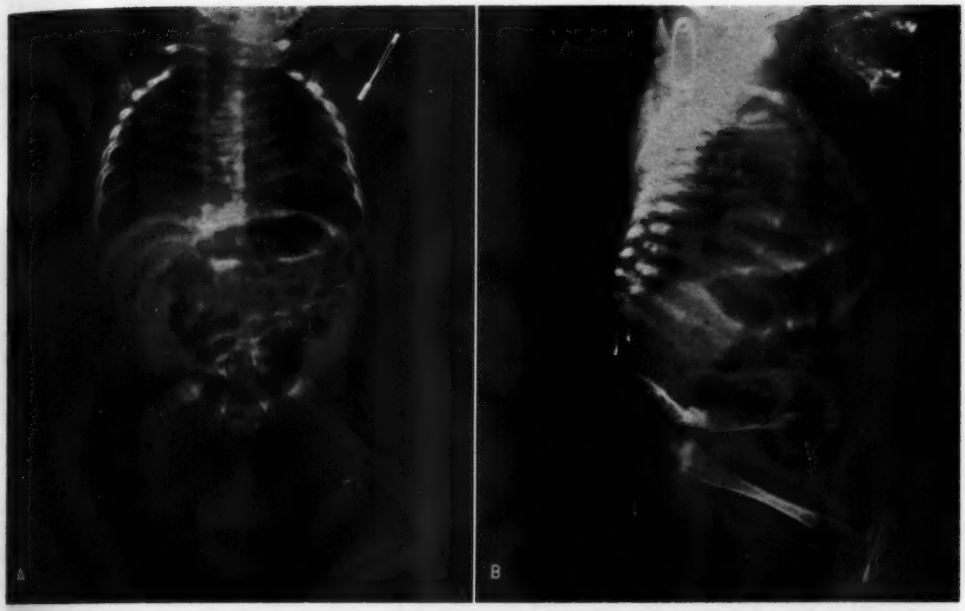


Fig. 3. Case I. A. Roentgenogram showing absence of lumbosacral vertebrae, with fusion of ilia posteriorly. B. View showing abrupt cessation of spine at T-12. The posterior rectal wall is visualized in contrast to subcutaneous fat. Increased fat content in the soft tissues and thighs outlines the blood vessels and/or nerves.

abruptly at the level of T-12, with complete absence of the lumbar and sacral vertebrae. The ilia were fused posteriorly. Acetabular components were misshapen and there was slight widening of the symphysis pubis. The normal water density of muscles of the thighs and legs was replaced by fat density. Vascular structures could be visualized in the lower extremities through the fat.

(Case I is reported with the kind permission of Dr. Daniel Costigan and Dr. James Riley, Orthopaedic Surgeons.)

CASE II (Fig. 4): A male infant was admitted to the Louisville General Hospital on Jan. 22, 1940, four hours after home delivery. No history was available, except that the parents were young, well, and had two other children in good health.

Physical examination revealed a small premature infant with hydrocephalus and a mass $3 \times 2 \times 1.5$ cm. at the level of T-12. The lower extremities were underdeveloped, and the examiner indicated that they showed no evidence of muscle. The knees were in 90° flexion, and webbing was present.

Roentgenograms obtained on Jan. 25, two days prior to death, revealed a rudimentary 12th dorsal vertebra with absence of all lumbar, sacral, and coccygeal vertebrae. The normal muscle bundle shadow was replaced by fat density. Vascular structures could not be identified in these films. The ilia were fused posteriorly. The infant died on the fifth postnatal day, of inanition.

EMBRYOLOGY

Three primary germ layers differentiate shortly after fertilization. The outermost layer of the resultant hollow sphere is the ectoderm, while the innermost layer is the entoderm. Mesoderm (middle layer) is composed of primitive tissue known as mesenchyme. Indentation of ectoderm results in formation of a primitive groove, while underyling dense mesenchymal tissue appears caudally and spreads cephalad. Soon after the nineteenth fetal day an axial rod, called the notochord, develops within the innermost portion of this band of mesenchymal tissue. Subdivision of the thickened mesoderm, now lying lateral and ventral to the notochord, by transverse clefts results in the formation of mesodermal segments (somites). The ventral-mesial wall of these segments, which now surround the neural canal, breaks down during the fourth fetal week and the aggregate of mesenchymal tissue, designated as a sclerotome, migrates toward the notochord, the lateralmost portion

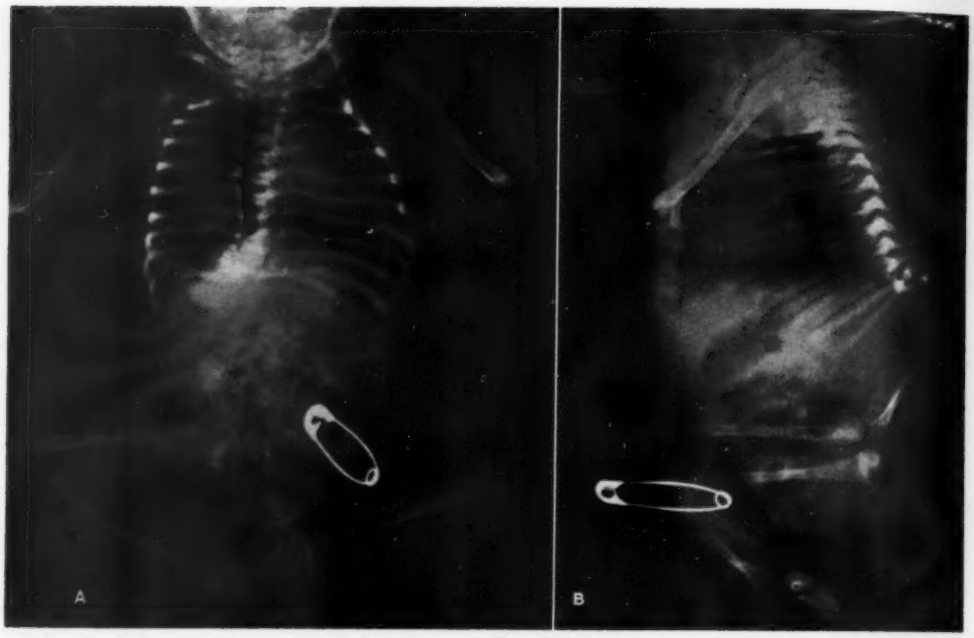


Fig. 4. Case II. A. Roentgenogram showing absence of lumbosacral spine and approximation of the ilia. The left ilium is deformed. B. View showing gibbus at level of rudimentary T-12 and essentially the same changes as in Case I.

of the somite retaining its position and becoming a myotome. This process begins cephalad (3). Through segmentation and recombination, the medial portions of the sclerotomes form vertebral bodies, while their dorsal portions flanking the neural tube form the vertebral arches. Centers of chondrification appear during the seventh fetal week, while ossification begins to replace chondrified centers in the tenth fetal week. The process of ossification originates in the lower dorsal region and spreads up and down until, by the twentieth week, centers have appeared in all bodies except the last two segments of the sacrum, which do not ossify until the thirtieth week (4).

Osseous structures of the lower extremities arise from unsegmented mesenchyme within the limb buds. Development of vascular structures is also independent of the mesodermal segments, the femoral artery budding from the external iliac artery while veins arise from the primitive capillary plexus of limb buds.

COMMENT

Complete absence of osseous tissue indicates that developmental arrest occurred at about the tenth fetal week. Rotund masses of osseous tissue, instead of lumbar and sacral vertebrae (5, 6) represent morphologic dysplasia after histogenesis of osseous tissues has started. Presumably the factors responsible for such changes had their effect much later in fetal life.

Etiologic factors for these and related anomalies are syphilis, poor nutrition, intrauterine inflammation, heredity, endocrine disorders, or severe illness (7). However, no definite extrinsic factor could be found in either of our cases. The clinical history, physical findings, and laboratory data are inadequate in Case II. Fusion or approximation of the ilia posteriorly is the usual finding with agenesis of the sacrum. A decrease in space between the lowest vertebra and the ilia is seen in Case I. Jorge (8) suggests that this is the result of pressure exerted on soft tissues by the weight of the torso.

In his case, in a twenty-four-year-old male with aplasia of the last three lumbar and all sacral vertebrae, fusion of the third lumbar vertebra with the ilia was successful. In a similar case, also reported by Jorge, muscular stability permitted standing and walking, with no apparent need for fusion. The short stature due to lack of vertebrae has been reported as another cause of dwarfism (7). Because of the lower extremity deformities, fusion was not considered feasible in our Case I. Vascular abnormalities suggesting absence or deficiency of sympathetic innervation of the lower extremities in related situations (6) was not present in these cases.

Exactly similar spinal defects were reported by Feller and Sternberg in a stillborn infant with hydrocephalus, blind colon, and absence of the right kidney and urinary bladder (9).

SUMMARY

Two cases of agenesis of the lumbar and sacral vertebrae in living children are presented. Associated anomalies are described with a discussion of pertinent embryology.

REFERENCES

1. CAFFEY, J.: Pediatric X-Ray Diagnosis. Chicago, Year Book Publishers, 3d ed., 1956, p. 1002.

2. SCHINZ, H. R., BAENSCH, W. E., FRIEDL, E., AND UEHLINGER, E.: Roentgen-Diagnostics. First American Edition (based on fifth German edition), edited by J. T. Case. New York, Grune & Stratton. Vol. II, 1952, p. 1485.

3. AREY, L. B.: Developmental Anatomy. A Textbook and Laboratory Manual of Embryology. Philadelphia, W. B. Saunders Co., 4th ed., 1940, pp. 371 and 394.

4. CUNNINGHAM, D. J.: Text-Book of Anatomy. Baltimore, Wm. Wood & Co. (Division of Williams & Wilkins Co.), 6th ed., revised by Arthur Robinson, 1931, p. 109.

5. BRAILSFORD, J. F.: Deformities of the Lumbosacral Region of the Spine. Brit. J. Surg. **16**: 562–627, April 1929.

6. BAUER, O.: Totale Aplasie der Lendenwirbelsäule bei einem Neugeborenen. Geburtsh. u. Frauenh. **12**: 250–256, March 1952.

7. GIANNINI, M. J., BORRELLI, F. J., AND GREENBERG, W. B.: Agenesis of the Vertebral Bodies—A Cause of Dwarfism. Am. J. Roentgenol. **59**: 705–711, May 1948.

8. JORGE, J. M., AND JORGE, H.: Agenesias sacrococcigeas (totale y subtotales). Rev. Asoc. méd. argent. **62**: 389–398, Aug. 15–30, 1948.

9. FELLER, A., AND STERNBERG, H.: Zur Kenntnis der Fehlbildungen der Wirbelsäule: über den vollständigen Mangel der unteren Wirbelsäulenabschnitte und seine Bedeutung für die formale Genese der Defektbildungen des hinteren Körperendes. Virchows Arch. f. path. Anat. **280**: 649–692, 1931.

School of Medicine
University of Louisville
Louisville 2, Ky.

SUMMARIO IN INTERLINGUA

Agenese Del Vertebras Lumbosacral

Es reportate un caso de complete absentia del vertebras lumbar e sacral in un infante de nove menses de etate. Le columna vertebral se terminava abruptemente al nivello de T-12; le ilios esseva fundite posteriormente; componentes acetabular esseva malformate; e le symphyse pubic esseva levemente allargate. Ambe le extremitates inferior esseva subdisveloppate, con nulle signo physic de disveloppamento muscular infra le coxas. In le roentgenogramma, le normal densitate de aqua del musculos del femores esseva reimplaciate per densitate de grassia.

Un caso simile esseva vidite in un neonato qui moriva ab inanition le quinte die post nato.

Le aspectos embryologic es discutite.

Bilateral Antecubital Ossicles (Fabellae Cubiti) and Other Rare Accessory Bones of the Elbow

With a Case Report[1]

GERHART S. SCHWARZ, M.D.

ACCESSORY ossicles are rare in the elbow. The one best substantiated is the patella cubiti at the dorsal aspect of the joint (1–5). Even here, some of the published reports do not conclusively eliminate the possibility of mistaking a traumatic fragment for a sesamoid ossicle of the triceps tendon. Other sources of diagnostic error are: an articulated olecranon spur (*i.e.*, a calcification in the triceps tendon at its attachment to the posterior aspect of the olecranon), calcareous bursitis dorsal to the triceps tendon, and loose bodies secondary to osteochondritis dissecans. Finally the epiphysis of the olecranon process may fail to unite with the body of the ulna in an occasional case (6). This epiphysis develops usually from two or three ossification centers, first appearing on radiographs at ten to thirteen years of age. When arrested, it may give the appearance of one or more separate ossicles in the dorsum of the elbow. Usually this can be recognized by the fact that the line of separation leads into or crosses the venous channel, which presents itself as a cyst-like rarefaction on lateral views of the ulna (7).

Persistence of the epiphysis for the medial and lateral epicondyle is not infrequent and a possible additional center between the medial epicondyle and the medial margin of the trochlea has been discussed by Zimmer (8*a*). This anomaly, which cannot be differentiated from loose bodies (9–14), will for sake of clarity be referred to as a paratrochlear ossicle, though no name has been given to it in the literature. In contrast, the volar aspect of the elbow is singularly free of anatomic variations leading to the formation of accessory ossicles or sesamoid bones.

Zimmer (see Köhler, 8*b*) mentioned the occasional development of an ossification center in the coronoid process, which sometimes persists. This he thought to be the "os cubiti anterior," to be discussed below. His two illustrations show a small structure which lies immediately adjacent to the coronoid process. Its shape causes it to appear as part of the process, which, without it, would appear incomplete.

In contradistinction, Simril and Trotter (15) have described a case of bilateral "*os cubiti anterius*" seen in a cadaver. Published radiographs are convincing in that the ossicles were ovoid in shape, smoothly delineated, and clearly separated from other bones of the elbow. In the following they will be referred to as antecubital bones. In an appended note mention is made of another case, also in a cadaver, seen by Dr. Edward A. Holyoke, but no illustrations are included. Two possibly similar cases have been encountered by Birkner (16).

The purpose of this communication is to report the roentgen demonstration of antecubital bones in a living patient.

CASE REPORT

A 37-year-old married white female was first seen in the Vanderbilt Clinic of the Columbia-Presbyterian Medical Center in 1952 for surgical fusion of the right ankle. Poliomyelitis contracted at the age of sixteen months had resulted in permanent paralysis of both lower extremities and the muscles of the spine. A transplant of the peroneus longus tendon to the scaphoid had been performed on either foot, at the age of eight years, for instability of the ankles. In 1932 bilateral subtalar arthrodeses and a rotation osteotomy of the right tibia were undertaken. A fenestration operation on the right labyrinth was performed for otosclerosis in 1952.

The right ankle fusion, performed shortly after

[1] From the Radiological Service of the Presbyterian Hospital, New York, N. Y., and the Department of Radiology, College of Physicians and Surgeons, Columbia University. Accepted for publication in May 1957.

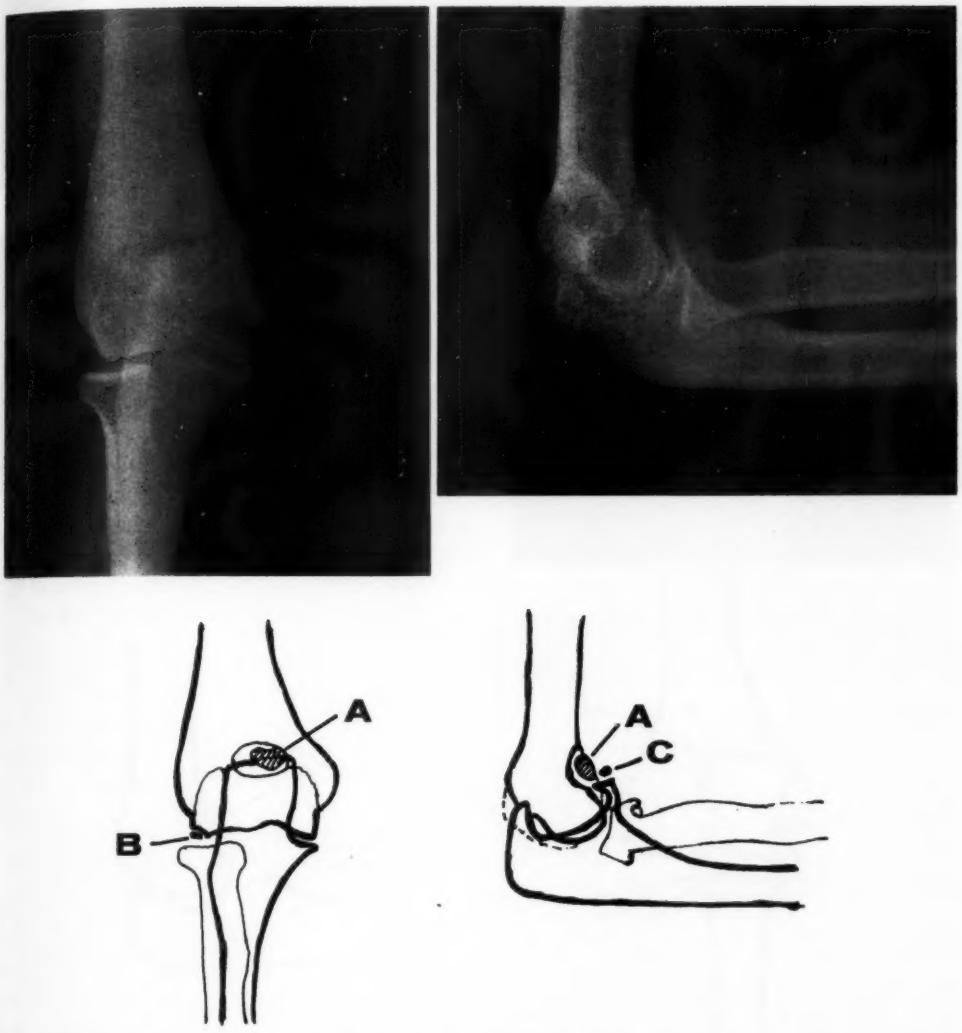


Fig. 1. Anteroposterior and lateral roentgenograms of right elbow, with tracings. A. Antecubital bone. B. Paratrochlear bone. C. Accessory coronoid.

the patient's first visit to the Vanderbilt Clinic, was successful, but on the occasion of a follow-up visit, March 16, 1953, she complained of poor function of the left elbow, which interfered with her newly accepted employment. She attributed it to a dislocation which she thought she had sustained about fifteen years earlier. She was referred to the Neurological Clinic, where an ulnar nerve palsy and weakness of the flexor carpi ulnaris were found. The flexor carpi ulnaris innervation, however, was completely intact, so that the neurologist was unwilling to attribute the nerve condition to injury to the elbow. He assumed that the complaints were caused by the use of a cane and prescribed crutches instead.

On the patient's next visit (Sept. 27, 1953) weakness in the intrinsic left hand muscles was found but the weakness of the flexor carpi ulnaris had disappeared. She was using a lighter cane and had abandoned her crutches. When last seen in the orthopedic clinic on Sept. 16, 1956, she had no more complaints referable to the elbow, wrist, or hand and was gainfully employed.

Roentgen Findings: Radiographs of the elbows (Figs. 1 and 2) reveal a sharply delineated ovoid ossicle at the volar aspect of each humerus. Each

Fig. 2. Anteroposterior and lateral roentgenograms of left elbow, with tracings. A. Antecubital bone.

measures approximately 6 × 11 mm. and seems to fit into the coronoid fossa of the humerus. On the anteroposterior view the ossicles are superimposed—in projection—upon the uppermost portion of the olecranon fossa. The two ossicles do not seem to move relative to the humerus when the elbow is being extended (anteroposterior view) or flexed (lateral view), but one cannot be certain of this, since the two projections are not comparable. In the right elbow a small ossicle is seen at the medial edge of the trochlea. Whether it represents a loose body secondary to osteochondritis dissecans or the aforementioned paratrochlear ossicle cannot be determined here, but the absence of symptoms favors the latter. Both elbows exhibit a moderate degree of osteoarthritis. The left radial head is deformed by what might be an old healed fracture.

Of interest is a fourth accessory ossicle immediately volar to the coronoid process of the right ulna. It appears to be identical with the ossicle described by Zimmer (8*b*). It may, however, represent a fragment of an osteophyte arising from the right coronoid process. Whatever its nature, simultaneous occurrence of this ossicle with an antecubital bone in the same elbow contradicts Zimmer's contention that the ossicles at the tip of the coronoid

reported by him are identical with the antecubital bones described by Simril and Trotter. For the purpose of distinction the term accessory coronoid ossicle is proposed. Again, since the right elbow is free of symptoms, it may represent a persistent epiphysis or a true accessory ossicle, but the presence of osteoarthritis radiographically is noted.

DISCUSSION

The close proximity of the antecubital ossicles to the coronoid fossa and their apparent lack of motion in relation to the humerus favors their lying within the elbow joint, as in the case of Simril and Trotter. The joint capsule inserts into the humerus *above* the coronoid fossa, so that the entire fossa is intra-articular. The ossicles may, however, be imbedded within the capsule or rest on the external surface of the capsule and still produce the picture here obtained. If so, their most logical location is the brachialis tendon. This tendon courses across the elbow joint in immediate proximity to the volar aspect of the joint capsule and inserts in the coronoid process of the ulna. This would make the antecubital bone (and perhaps also the "accessory coronoid" ossicle) a true sesamoid ossicle in analogy to the fabella of the knee.

One might speculate also on the connection between poliomyelitis in early life and the formation of these ossicles. It may be that relaxation of the antagonist muscles permitted the elbows to be habitually overextended. This would increase the friction between the brachialis tendon and the volar aspect of the humerus just as a chronic back knee produces increased friction between the femur and the gastrocnemius. If friction can stimulate the formation of sesamoids, an analogy may be found in the knee of the horse which has normally a back knee. It not only possesses a large fabella in the lateral but also a cyamella in the medial gastrocnemius tendon. Also, somewhat against a genetic explanation is the fact that the patient here described was of the white race, whereas both previously reported instances of antecubital bones were encountered in Negroes.

SUMMARY

A case of bilateral antecubital bones associated with a unilateral accessory ulnar coronoid ossicle or fragment and with a unilateral paratrochlear bone or fragment is reported. This appears to be the first example of antecubital bones diagnosed during life. The simultaneous existence of an accessory coronoid bone or fragment with an antecubital bone makes it obvious that these two conditions are not identical as was hitherto assumed. The name "fabella cubiti" is proposed for the antecubital bone. This terminology is based upon regional, not etiological, analogy.

The Presbyterian Hospital
622 W. 168th St.
New York 32, N. Y.

REFERENCES

1. KREMSER, K.: Ein Beitrag zur Kasuistik der Skelettanomalie (Ellenbogenscheibe). Röntgenpraxis **6**: 371–374, June 1934. Ein weiterer Beitrag zum Kapitel der Ellenbogenscheibe. Ibid. **10**: 841–844, December 1938.

2. VON BRÜCKE, H.: Über die Patella cubiti, eine seltene Abweichung des Ellenbogenskelettes. Ztschr. f. Orthop. **73**: 158–160, 1942.

3. WÜLFING, M.: Über akzessorische Knochen des Ellenbogens. Fortschr. a. d. Geb. d. Röntgenstrahlen **34**: 684–688, 1926.

4. KIENBÖCK, R., AND DESENFANS, G.: Über Anomalien am Ellbogengelenk. Patella cubiti. Beitr. z. klin. Chir. **165**: 524–529, 1937.

5. ZEITLIN, A. A.: Traumatic Origin of Accessory Bones at the Elbow. J. Bone & Joint Surg. **17**: 933–938, October 1935.

6. SCHMITT, H. G.: Persistierende Apophyse des Olecranons. Fortschr. a. d. Geb. d. Röntgenstrahlen **74**: 241, February 1951.

7. IANNACCONE, G., AND BARILLÀ, M.: Die zystenartige Gebilde am Proximalende der Ulna: Anatomisch-röntgenologisches Bild und dessen Auslegung. Fortschr. a. d. Geb. d. Röntgenstrahlen **84**: 598–603, May 1956.

8. KÖHLER, A.: Borderlands of the Normal and Early Pathologic in Skeletal Roentgenology. Tenth Edition, revised by E. A. Zimmer. English translation arranged and edited by J. T. Case. New York, Grune & Stratton, 1956. (*a*) p. 140 and Fig. 325; (*b*) p. 129 and Figs. 307 and 308.

9. GÜNSEL, E.: Persistierende Apophyse des Epicondylus medialis humeri. Fortschr. a. d. Geb. d. Röntgenstrahlen **76**: 660–661, May 1952.

10. DE CUVELAND, E.: Persistierende Knochenkerne des Epicondylus ulnaris und radialis. Fortschr. a. d. Geb. d. Röntgenstrahlen **82**: 125, January 1955.

11. MCLEARIE, M., AND MERSON, R. D.: Injuries to the Lateral Condyle Epiphysis of the Humerus in Children. J. Bone & Joint Surg. **36-B**: 84–89, February 1954.

12. SAN NICOLO, M. R.: Eine seltene Veränderung am Ellenbogengelenk. Fortschr. a. d. Geb. d. Röntgenstrahlen **84**: 378–379, March 1956.

13. SIECKEL, L.: Über die persistierenden Knochenkerne am Ellenbogengelenk. Fortschr. a. d. Geb. d. Röntgenstrahlen **85**: 709–716, December 1956.
14. SCHRÖDER, G.: Zur Problem der persistierenden Knochenkerne des Epicondylus humeri ulnaris et radialis. Fortschr. a. d. Geb. d. Röntgenstrahlen **85**: 716–719, December 1956.
15. SIMRIL, W. A., AND TROTTER, M.: An Accessory Bone and Other Bilateral Skeletal Anomalies of the Elbow. Radiology **53**: 97–100, July 1949.
16. BIRKNER, R.: Personal communication.
17. GRASHEY-SCHWARZ: X-ray Chart of the Human Skeleton; Normal Variations of Clinical Importance. New York, Stechert-Hafner, Inc., 1957.

SUMMARIO IN INTERLINGUA

Bilateral Ossiculos Antecubital (Fabellas De Cubito) E Altere Ossos Accessori Rar Del Cubito, Con Le Reporto De Un Caso

Es reportate un caso de bilateral ossos antecubital, associate con unilateral accessori ossiculo o fragmento coronoide ulnar e unilateral osso o fragmento paratrochlear. Isto pare esser le prime exemplo de ossos antecubital diagnosticate durante le vita del subjecto. Le existentia simultanee de un accessori osso o fragmento coronoide e un osso antecubital rende obvie que iste duo conditiones non es identic Le termino "fabella de cubito" es proponite pro le osso antecubital. Le base pro iste terminologia es un analogia regional e non etiologic.

Gastric Deformity from Extrinsic Pressure by Calcified Splenic Artery

MURRAY A. ROSENBERG, M.D., and MILTON ELKIN, M.D.

CALCIFICATION of the branches of the celiac artery is not an uncommon observation on roentgenograms of the abdomen in elderly patients. The celiac trunk branches from the abdominal aorta just below the aortic hiatus in the diaphragm and divides into three branches close to its origin. The splenic artery branch proceeds to the left, behind the stomach, and courses horizontally along the superior border of the pancreas to the hilus of the spleen (Fig. 1). The course is normally tortuous and this tortuosity becomes more pronounced with aging. In elderly patients, also, the walls of the splenic artery frequently show calcification. It is not surprising, therefore, in view of the close proximity of the splenic artery to the posterior lesser curvature of the stomach in the region of the cardia, that an exceptionally tortuous artery, and especially one which has become rigid due to calcific atherosclerosis, may produce a pressure defect simulating an intrinsic gastric lesion.

One of our patients, having gastrointestinal symptoms due to other causes, presented this deformity on barium study; early carcinoma of the stomach was considered a possible diagnosis from the x-ray appearance, and the patient underwent surgery. Retrospectively it appeared that a correct diagnosis could have been made. In a short period of time, we have seen 4 additional cases with similar roentgen findings. Our diagnosis in these subsequent cases has been "extrinsic pressure defect of the stomach due to a calcified tortuous splenic artery." These last four patients have been spared operation and continued follow-up indicates that our premise is probably correct.

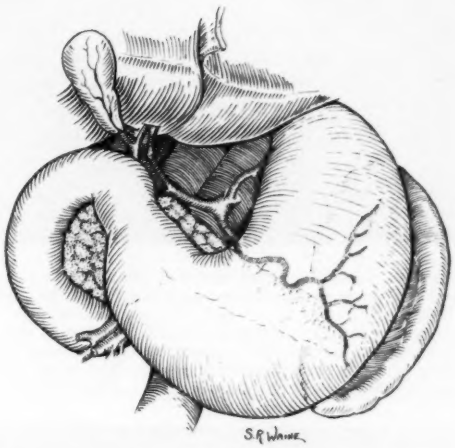


Fig. 1. Course of the normally tortuous splenic artery, behind the stomach, from the celiac axis to the spleen. The artery, when of increased rigidity and tortuosity due to atherosclerosis, may cause an extrinsic pressure defect at the point of its passing posteriorly to the lesser curvature of the stomach.

CASE I: R. R., an 84-year-old white female, was admitted to the hospital several hours following an episode of hematemesis, when about a cupful of bright red blood was vomited. She gave a history of anorexia and occasional nausea for the past several months but there had been no significant recent weight loss. Nor had there been any previous episodes of hematemesis or melena. The patient appeared pale and thin. No abnormal abdominal masses could be palpated, and rectal examination was negative. The blood pressure was 140/90; hemoglobin 10.2 gm.; hematocrit 36 per cent. Gastric aspiration produced dark red material, guaiac-positive.

A gastrointestinal series on the day following admission (Fig. 2) showed a persistent deformity of the lesser curvature of the stomach in the region of the cardia. A definite diagnosis could not be made from this study, and three days later the series was repeated, demonstrating the same deformity (Fig. 3). Although a neoplasm of the stomach could not be definitely excluded, deformity due to extrinsic pressure seemed more likely from the roentgenographic appearance. The nature of the possible extrinsic mass, however, was not correctly diagnosed. The calcified splenic artery was considered to have no bearing on the gastric findings.

In view of the severity of the patient's symptoms

[1] From the Department of Radiology, Bronx Municipal Hospital Center, and the Department of Radiology, Albert Einstein College of Medicine, Yeshiva University, New York, N. Y. Accepted for publication in July 1957.

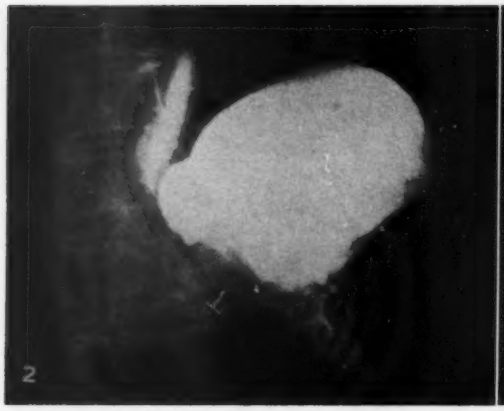


Fig. 2. Case I. Anteroposterior film with the patient in Trendelenburg position, showing a filling defect of the upper lesser curvature in the region of the cardia. An intrinsic lesion of the stomach could not be definitely excluded.

Fig. 3. Case I. Restudy a few days later, again demonstrating a fixed concavity in the region of the cardia. Although no mass could be shown within the lumen of the stomach and mucosal destruction was not evident, an early neoplasm was thought possible. The calcified splenic artery was apparent but at this time was thought to bear no direct relationship to the gastric deformity.

Fig. 4. Case II. Filling defect along the upper lesser curvature in the region of the cardia, adjacent to the calcified splenic artery. The rings of increased density near the lower greater curvature represent barium-containing diverticula of the splenic flexure, from a previous barium enema.

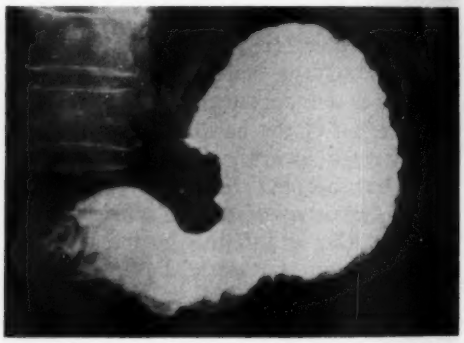


Fig. 5. Case III. The appearance here is similar to that of the previous cases. A concave defect is present on the lesser curvature adjacent to the calcified splenic artery.

and lack of proper explanation for the deformity near the cardia, surgery was undertaken, with preoperative diagnosis of "possible neoplasm of the stomach." At operation the splenic artery was found to be calcified and markedly tortuous, impinging on the posterior aspect of the stomach at the upper lesser curvature, explaining the roentgen defect. There were no adhesions between the artery and the stomach. The stomach was explored but no gross lesions could be seen. However, because of the possibility that the episode of bleeding might be due to superficial gastric erosions, a subtotal gastrectomy was performed.

The pathological examination revealed chronic gastritis with prominent rugae, but there was no evidence of tumor.

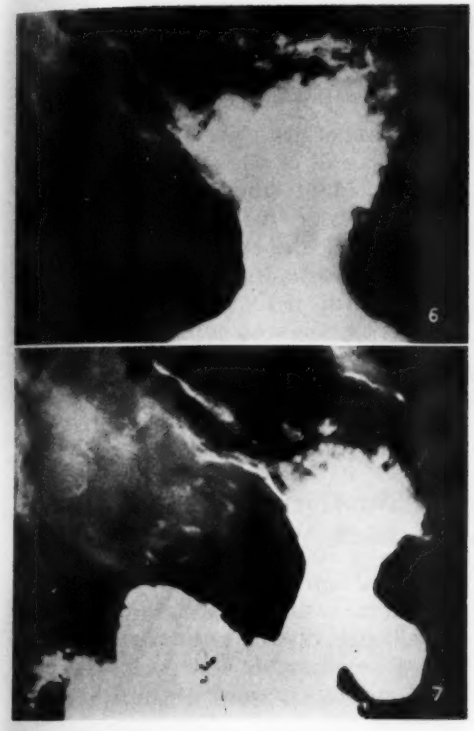


Fig. 6. Case IV. There is a zone of straightening of the upper lesser curvature in close proximity to the calcified splenic artery. Although an infiltrating neoplasm could cause such a straightening, the appearance was attributed to pressure from the adjacent splenic artery.

Fig. 7. Case IV. Repeat study five months later again demonstrates the slight defect along the upper lesser curvature.

CASE II: J. P., a 70-year-old white male, was admitted to the hospital for treatment of congestive heart failure. Except for intermittent episodes of nausea believed to be related to medication (digitalis), he had no gastrointestinal complaints. Laboratory studies revealed no evidence of anemia, and the stools, on repeated examination, were guaiac-negative. A gastrointestinal series showed a concave deformity of the upper lesser curvature believed to be caused by the adjacent calcified, tortuous splenic artery (Fig. 4). Although this case has not been proved by operation, subsequent clinical course has shown no evidence of intrinsic gastric abnormalities.

CASE III: M. C., a 66-year-old Puerto Rican female, was admitted to the hospital because of fatty food intolerance for eight years. Blood studies revealed no anemia. A cholecystogram showed multiple gallstones. The gastrointestinal

Fig. 8. Case IV. This patient has had a subtotal gastric resection and a gastroenterostomy. The lesser curvature proximal to the site of the anastomosis appears irregular, adjacent to the calcified splenic artery. The straightening and irregularity of the lesser curvature here are thought to be due to extrinsic pressure from the tortuous and calcified splenic artery.

series (Fig. 5) showed a marked, concave filling defect of the lesser curvature in close proximity to a calcified splenic artery. This deformity was considered to be due to extrinsic pressure by the artery. At subsequent cholecystectomy, careful palpation of the stomach revealed no lesions; the tortuous, calcified splenic artery was noted.

CASE IV: E. S., a 73-year-old white female, hospitalized for myocardial infarction, had an episode of hematemesis. Her past history revealed no evidence of melena or hematemesis, although she had had intermittent epigastric pain and discomfort for many years. The gastrointestinal series (Fig. 6) showed straightening of the upper lesser curvature of the stomach, considered to be related to the adjacent markedly tortuous and calcified splenic artery. Other films of this series demonstrated a small ulcer of the lower lesser curvature, probably the site of the bleeding.

On a medical régime, the ulcer diminished slowly in size but the epigastric pain was not wholly relieved. Because of the patient's age and poor cardiac status, surgery was not advised for the ulcer. A later gastrointestinal series (Fig. 7) again demonstrated the deformity.

At autopsy, following death from heart disease, some scarring of the lower lesser curvature (site of healed peptic ulcer) was found. The cardia and upper lesser curvature of the stomach appeared normal. The splenic artery was markedly calcified and tortuous.

CASE V: M. N., a 68-year-old white female, was admitted to the hospital because of vomiting.

One month previously, at another hospital, she had undergone a subtotal, antecolic Polya gastrectomy for a benign gastric ulcer, which was completely removed. At time of surgery, direct examination of the upper part of the stomach revealed no abnormalities. A "dumping syndrome" developed immediately following the operation.

On admission to our hospital the patient showed no anemia, and the stool was guaiac-negative. A gastrointestinal series (Fig. 8) showed a well functioning gastroenterostomy, with slight dilatation of the efferent loop. The lesser curvature of the remaining portion of the stomach, just proximal to the anastomosis, appeared straightened and slightly irregular, in close proximity to a heavily calcified splenic artery. In view of the recent direct negative examination of this portion of the stomach at surgery, it was believed that the present deformity was due to pressure by the artery. The patient improved under conservative therapy and was discharged. She has been well on subsequent follow-up studies.

SUMMARY

Because of its close proximity to the posterior wall of the stomach, a sclerotic and markedly tortuous splenic artery may cause a pressure defect of the upper lesser curvature of the stomach, simulating an intrinsic gastric lesion. Five such cases are reported. In a gastrointestinal series such a defect is seen adjacent to a portion of the easily visualized calcified splenic artery.

Albert Einstein College of Medicine
New York 61, N. Y.

SUMMARIO IN INTERLINGUA

Deformitate Gastric In Consequentia De Extense Pression Per Un Calcificate Arteria Splenic

A causa de su proximitate al pariete posterior del stomacho, un arteria splenic que es sclerotic e marcatemente tortuose pote producer un defecto de pression in le curvatura minor superior del stomacho, simulante un intrinsec morbo gastric. Cinque tal casos es reportate. In un serie de pelliculas gastrointestinal, un tal defecto es visibile adjacente a un portion del calcificate arteria splenic.

Newer Methods for Symmetrical Roentgenography of the Intervertebral Foramina of the Cervical Spine and Optic Foramina[1]

SOL FINEMAN, M.D., F.A.C.R.[2]

INTERVERTEBRAL FORAMINA OF THE CERVICAL SPINE

Narrowing of the intervertebral foramina of the cervical spine may result from fractures, dislocations, or traumatic subluxations; from bone productive changes in cases of discogenic degenerative disease, hypertrophic spondylosis, or degenerative arthrosis of the posterior articulations of the lateral intervertebral or so-called covertebral or Luschka joints; from hypertrophic arthrosis secondary to subluxations following whiplash injuries; or from fracture-dislocations of the cervical spine. Such constrictions and distortions may irritate or compress the cervical nerve roots, producing a variety of symptoms: pains radiating to the sides of the head, eyes, and ears; pains simulating arthritis, neuritis, fibrositis, bursitis, or angina pectoris (1); or a group of symptoms (2) said to result from pressure upon the vertebral sympathetic plexus, namely, deep or superficial pain in the head, face, throat, or sinuses, aphonia, vertigo, tinnitus, corneal ulcerations, flushing, lacrimation, and salivation.

Roentgenographically correct and symmetrical visualization of the intervertebral foramina of the cervical spine is essential for the evaluation of these pathologic changes which may distort and constrict the foramina, with consequent pressure on the cervical nerve roots. One finds in the literature repeated warnings (3–5) relative to the importance of correct radiographic projection of the foramina and the avoidance of radiographic distortions which may be erroneously interpreted as of pathologic significance.

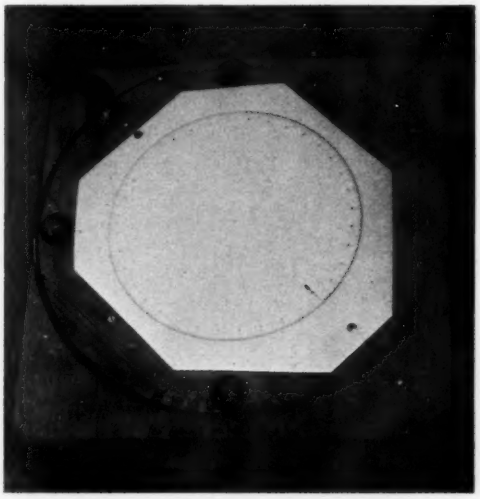


Fig. 1. Swiveled base for revolving chair, showing angles extended from paper protractor to the top circular platform and to the base board.

In order to avoid the difficulties and pitfalls often encountered, the writer has constructed a revolving chair, which, when used in conjunction with an attached head clamp or with a plumb line, has eliminated technical difficulties and made possible consistently satisfactory, symmetrical roentgenograms of the structures under consideration.

Construction of Revolving Chair and Technic of Examination: The revolving chair is constructed as follows: A 5-ply wooden board measuring 24 × 24 inches forms the base. Attached to this at the center by a steel swivel of the "lazy Susan" type, available commercially, is a circular board, also of 5-ply wood, measuring 22 inches in diameter. The swivel measures 11 inches in diameter and is strong enough

[1] Presented at the Eastern Conference of Radiologists, New York, N. Y., March 7-9, 1957. Accepted for publication in May 1957.

[2] Attending Roentgenologist, Montefiore Hospital, New York, N. Y. Associate Clinical Professor of Radiology in Columbia University, New York, N. Y.

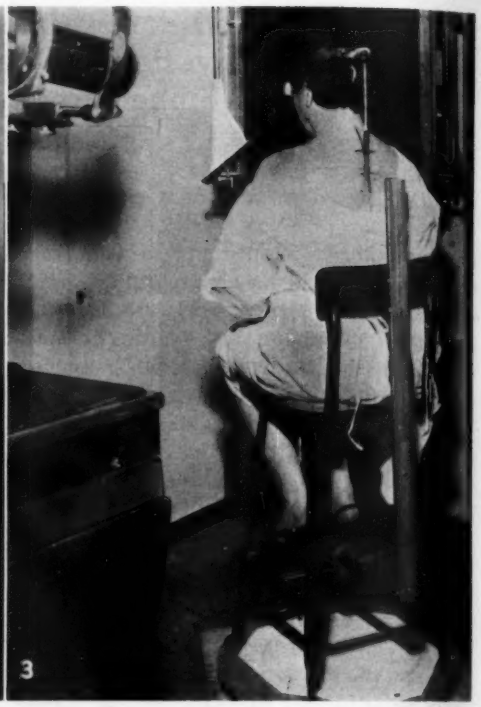


Fig. 2. Patient seated on swivel chair, with head clamp in place at the parietal bone level and rotated into the left anterior oblique position.

Fig. 3. Alternative technic. Patient in position for radiography of the right intervertebral foramina without the use of a head clamp. The head and neck are rotated into the correct position by means of a plumb line suspended from a head band mirror.

to permit easy rotation of the chair with the patient in it. A circular paper protractor is centered over the revolving board and fixed to it. The angles indicated on the protractor are then extended to the circular board and, over its edge, to the base. board, being marked off on each of these, from 1 to 180° to the right and left of the zero (0) mark. This makes it possible to rotate the patient the desired number of degrees up to 180 in either direction (Fig. 1).

A metal stool with a back rest, of the type commercially available, is centered on the circular board, adjusted so that the center of the back rest coincides with the "0" mark on the board, and is fastened in place. A head clamp, also of a type commercially available, is then attached to the center of the back of the chair by means of a sliding steel channel bar. This permits the elevation and lowering of the clamp, to fit the height of the patient under examination.

The patient is seated in the revolving chair, facing the Bucky diaphragm. The head clamp is applied to the sides of the skull, the chin is depressed to straighten the cervical curve, and the chair is rotated 45° to the right. The exposure is made, preferably at a 4-foot target-film distance, the central ray pointing 10 to 15 degrees caudad and passing through the fourth cervical vertebra. The chair is then rotated 45 degrees to the left (Fig. 2) and a second exposure is made.

By covering half of an 11 × 14-inch film with a lead mask and shifting the exposed part of the cassette as near as possible to the center of the Bucky diaphragm tray, the two exposures can be made on a single film. Since the patient's position has re-

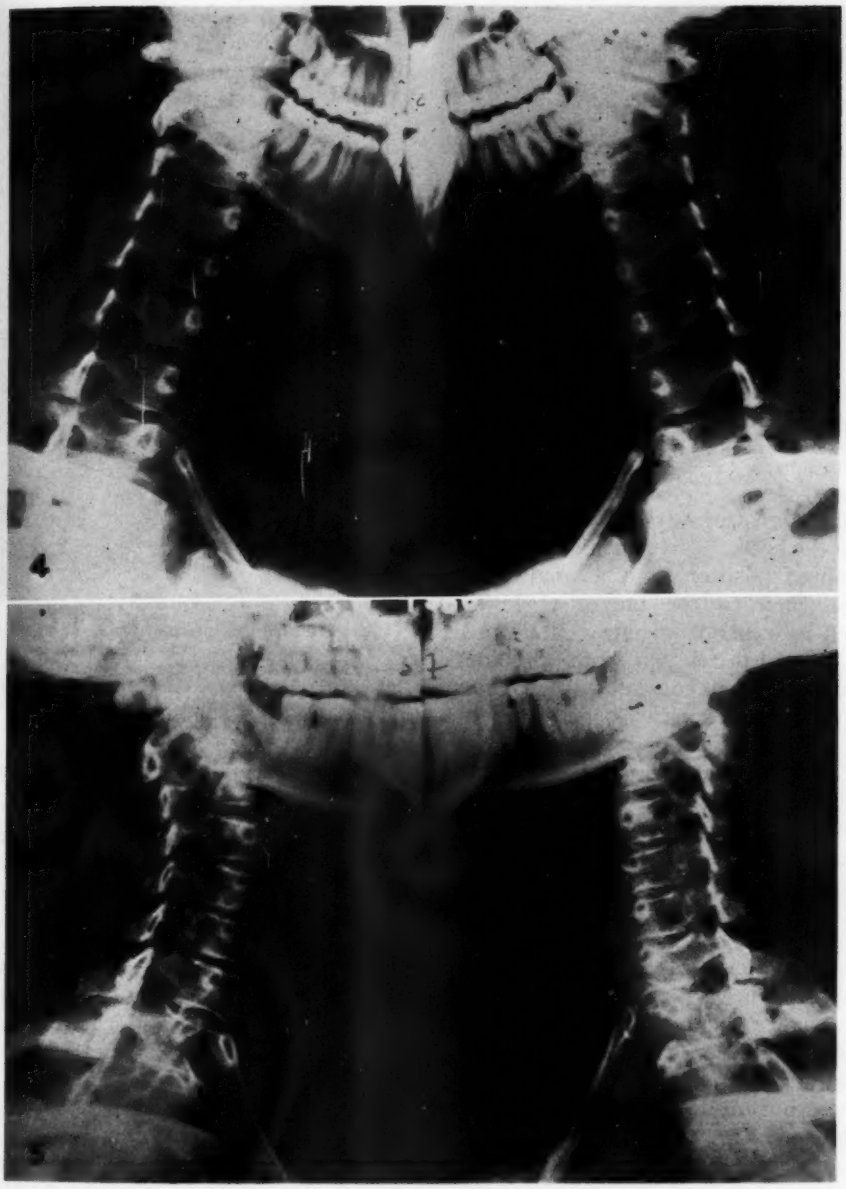


Fig. 4. Symmetrical visualization on one film of the cervical intervertebral foramina of both sides.
Fig. 5. Symmetrical visualization of the intervertebral foramina of both sides on one film. The fifth and sixth Luschka joints show exostoses projecting into the foramina.

mained unchanged one obtains a symmetrical view of the intervertebral foramina of both sides on one film (Figs. 4 and 5).

The head clamp, while desirable, is not essential. One can achieve symmetrical rotation of the head, neck, and trunk, and identical flexion and extension of the head and neck, by the following procedure:

A head band, with a mirror of the type commonly used by rhinologists, is adjusted

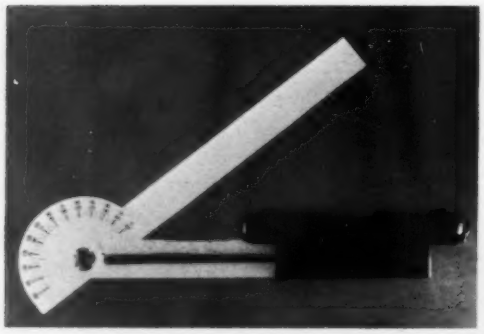


Fig. 6. Angle ruler with level attached to bottom arm used to elevate the orbito-meatal line to the required height. Elevation of the orbito-meatal line approximately 35 to 45° from the horizontal will, in most instances, raise the optical canal into a horizontal position and permit alignment of the central rays of the x-ray tube with the long axis of the canal.

with the mirror centrally placed at the back of the head. The head is brought into the desired position, and a small plumb line attached to the mirror is lowered through its central opening. If the head is not rotated in relation to the shoulders, the plumb line will coincide with a vertical line drawn with a wax pencil over the spinous processes of the cervical and upper dorsal spine. The degree of desired flexion or extension of the head is indicated by a horizontal line marked off, with a wax pencil, on the vertical line. The chair is then rotated into the desired oblique position, the relationship of the plumb line to the penciled lines over the spine is checked, the head is readjusted, if necessary, and the first exposure is made (Fig. 3).

The chair is then rotated into the opposite oblique position, and the head is again adjusted, just prior to the roentgenographic exposure, to make certain that the plumb line and wax-penciled lines over the spine coincide. The results, in the writer's experience, have been comparable to those obtained by immobilization of the neck and head with the head clamp.

OPTIC CANALS

The revolving chair described above has been found also to be satisfactory for roentgenography of the optic canals. These tubular passages in general range in length from 4 to 9 mm. (6) but may even reach a length of 12 mm. (7).

The optic canals, if projected, would reach the outer lower quadrant of the orbits, since they point approximately 38° laterally and 38° downward from their origin in the lesser wings of the sphenoid

Fig. 7. Patient in position for radiography of the left optic canal. The chin is elevated by the head clamp for elevation of the orbito-meatal line, in order to bring the long axis of the optic canal into the horizontal position. Dental occlusal film held at a right angle to the central beam of the x-ray tube.

bones. To demonstrate these canals radiographically in their true contour, each orbit must be elevated approximately 38° and rotated medially approximately the same number of degrees in order to align the canal with the central ray of the x-ray tube.

The downward and outward direction of the optic canals varies somewhat in different individuals and cannot be foretold by reference to any facial bony landmarks (8). A trial roentgenogram, however, based on a standard upward elevation and medial rotation of the skull, will reveal the correction required for the proper projection of the canal into the outer lower quadrant of the orbit. By means of the revolving chair and head clamp, and with the aid of an angle ruler (Fig. 6), this objective can be attained. A trial roentgenogram of the optic canal is obtained, its position in relation to the outer lower quadrant is noted, and the necessary correction of angulation can

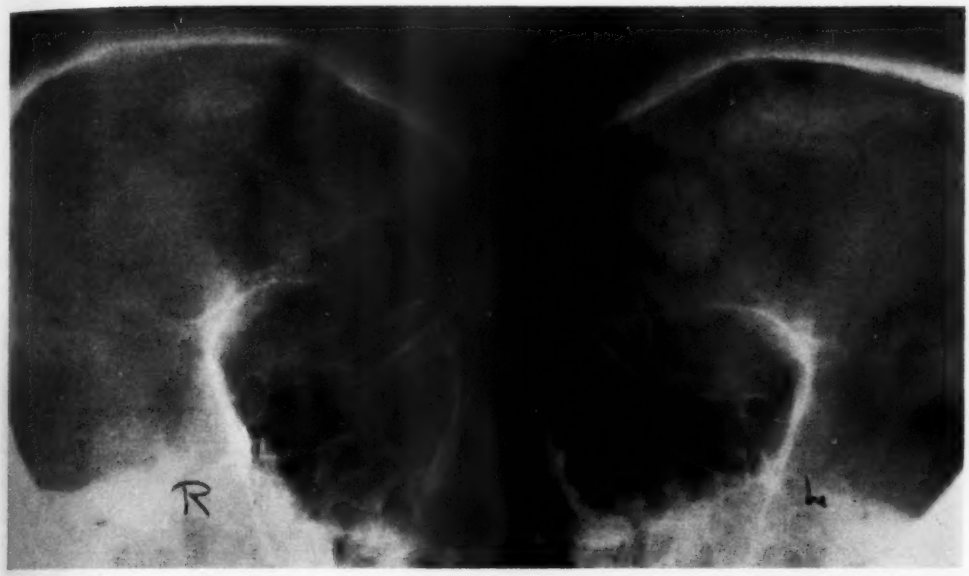


Fig. 8. Right and left optic canals on a single film, obtained by rotation of the patient into both oblique positions and by elevation of the orbito-meatal lines.

easily be made to bring the canal into this quadrant of the orbit.

Procedure: The roentgenographic procedure is carried out as follows: The orbito-meatal line is marked on the patient's face with a wax pencil. With the aid of the angle ruler, a second line is drawn from the meatal end of the first line at a 38° angle anteriorly and downward. The patient is seated in the revolving chair, the head clamp is adjusted under the chin, and the chin is elevated until the line drawn at an angle to the orbito-meatal line, as described, is elevated to the horizontal position. The chair is then rotated 38° to the right for the right orbit, or to the left for the left orbit, and the x-ray tube, with a long narrow cone, is focused on the orbit through the posterior aspect of the skull (Fig. 7).

Roentgenograms of both optic canals can be obtained on a single 10 × 12-inch film (Fig. 8) by covering the alternate halves of the cassette with a lead mask. The film is placed at right angles to the central beam of the x-ray tube to avoid distortion.

Since, as previously stated, the exact downward and lateral angulation of the optic canal cannot be predicted, the roentgenogram may show that the optic canal has not been optimally projected. The necessary correction of angulation can then be made, resulting in the optimal localization of the canal within the outer and lower quadrant of the orbit.

If desired, dental occlusal films may be used. These small films may be placed in a film holder (Fig. 7) designed to bring the film in contact with the orbit or may be suspended in front of the orbit from a head band of the type used by rhinologists.

SUMMARY

1. The cervical syndrome consists of a group of bizarre symptoms, which result from pressure or irritation of the cervical nerve roots and/or cervical sympathetic plexuses.

2. The pressure or irritation of these nerves may result from constriction of the cervical intervertebral foramina, immediately following fractures, dislocations, or subluxations of the cervical spine, or from degenerative hypertrophic bony overgrowth secondary and as a late sequel to trauma to the cervical spine, or from non-

traumatic hypertrophic arthroses of the articulations of the cervical spine.

3. Roentgenographically correct and symmetrical visualization of the cervical intervertebral foramina is essential for the proper evaluation of constriction of the foramina.

4. A revolving chair and technic are described which make possible consistently good and symmetrical visualization on one film of the intervertebral foramina on both sides of the cervical spine.

5. The revolving chair can be utilized also for roentgenography of the optic canals.

133 East 58th Street
New York 22, N. Y.

REFERENCES

1. JACKSON, R.: The Cervical Syndrome. American Lecture Series: A Monograph in American Lectures on Orthopedic Surgery. Springfield, Ill., Charles C Thomas, 1956.

2. HADLEY, L. A.: The Spine. Springfield, Ill., Charles C Thomas, 1956.

3. EPSTEIN, B. S.: The Spine: A Radiological Text and Atlas. Philadelphia, Lea & Febiger, 1955.

4. OPPENHEIMER, A., AND TURNER, E. L.: Discogenetic Disease of the Cervical Spine with Segmental Neuritis. Am. J. Roentgenol. **37**: 484–493, April 1937.

5. HADLEY, L. A.: Roentgenographic Studies of the Cervical Spine. Am. J. Roentgenol. **52**: 173–195, August 1944.

6. WHITNALL, S. E.: The Anatomy of the Human Orbit and Accessory Organs of Vision. New York and London, Oxford University Press, 2d ed., 1932.

7. ONODI, A.: The Optic Nerve and the Accessory Sinuses of the Nose. New York, William Wood & Co., 1910.

8. GOALWIN, H. A.: The Clinical Value of Optic Canal Roentgenograms. Arch. Ophth. **55**: 1–20, January 1926.

SUMMARIO IN INTERLINGUA

Nove Methodos pro le Roentgenographia Symmetric del Foramines Intervertebral in le Cervical Columna Dorsal e del Foramines Optic

Le restriction del foramines intervertebral in le cervical columna dorsal pote esser effectuate per un varietate de causas, incluse fracturas, dislocationes o subluxationes, morbos degeneratori, e arthrosis hypertrophic. Tal distortiones pote resultar in pression o irritation del radices del nervos cervical e/o del plexos sympathic cervical con le consequente production de symptomas. Un roentgenographicamente correcte demonstration symmetric del foramines intervertebral es indispensabile in le evalutation de iste alterationes.

Es describite le construction de un sede giratori per medio del qual il ha devenite possibile obtener uniformemente bon symmetric visualisationes del foramines a ambe lateres super le mesme pellicula. Le capite pote esser positionate per medio de un crampa o alternativemente per medio de un banda a que un speculo es attachate. Le sede es etiam usabile in le examine roentgenographic del canales orbital.

Magnification Technic in Roentgenography of the Chest[1]

THEODORE E. KEATS, M.D., and GEORGE F. KOENIG, R.T.

THE PURPOSE of this report is to point out the usefulness of the magnification technic in roentgenography of the chest. In recent years, methods of enlarging the roentgenographic image to improve diagnostic accuracy have gained in popularity, particularly with the advent of the 0.3-mm. focal spot roentgen tube, which has made this type of examination technically more feasible. For the most part, use of this technic has been confined to magnification of images of skeletal parts (1, 2). It is not generally appreciated that it may also be applied to pulmonary roentgenography.

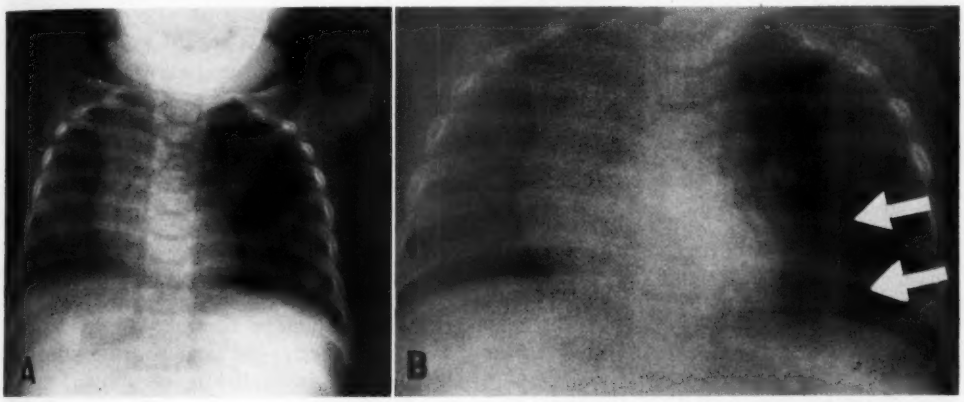


Fig. 1. A. Anteroposterior roentgenogram of the chest showing increased radiability of the left hemithorax with displacement of the mediastinum to the right.
B. Anteroposterior roentgenogram of the chest with magnification technic, showing evidence of overexpansion of the entire left upper lobe and demonstrating the major interlobar fissure and a pulmonary cyst projected below the left hilus.

TECHNIC

Because of the long exposures believed to be necessary with the magnification technic, its use has been limited to parts which can be immobilized and it has seemed to be precluded in chest radiography where respiratory motion is always a problem. It is accepted that exposure times of one-tenth to one-thirtieth of a second are necessary to overcome this difficulty. While this is easily accomplished with high-energy equipment in the 100- to 500-ma range, the capacity of the 0.3-mm. focal spot tube is only 10 to 15 ma and these short exposures are not possible at the conventional range of 60 to 80 kv, at 72 inches distance. The solution of this problem was found by using the maximum kilovoltage permitted by the tube rating chart, namely 100 kv, in order to obviate the longer exposure necessitated by the low milliampere rating of the 0.3-mm. focal spot tube.

The examination is performed as follows: The patient is positioned on the radiographic table. A cassette is placed upon a support at a distance of 15 inches below the top of the table. The tube-film distance is fixed at 40 inches. Technical factors are 100 kv, 10 ma, time one-twentieth of a second for children and one-tenth of a second for adults. Heavier adults may require an increase to 15 ma.

[1] From the Department of Radiology, University of Missouri School of Medicine, Columbia, Mo. Accepted for publication in May 1957.

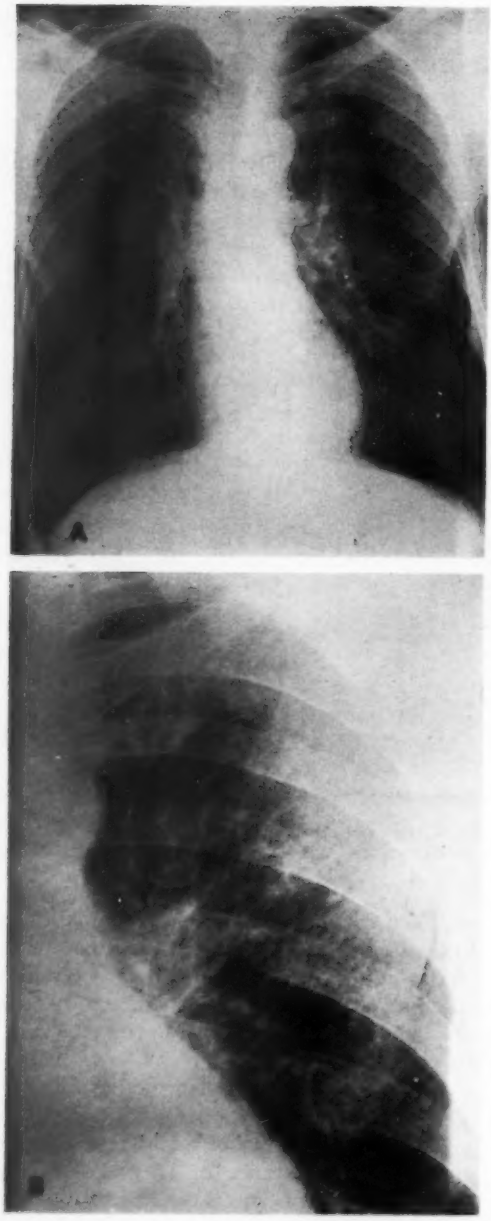


Fig. 2. A. Postero-anterior roentgenogram of the chest showing pulmonary emphysema and extensive linear and reticular density throughout. Within some of the densities there is a suggestion of faint calcification.

B. Postero-anterior roentgenogram of the chest with magnification technic, showing no evidence of calcification in the parenchymal infiltrates. The distribution of the linear densities suggests pulmonary fibrosis.

Par speed screens are used without Potter-Bucky diaphragm.

The focal-chest distance and film-object distance are fixed as described above so that the object will not be magnified more than 2×. This is the inherent limit of magnification for this method when the 0.3-mm. focal spot tube is used (1). Magnification of this degree is obtained when the object-film distance is equal to the target-object distance.

Motion is no more detectable in the resultant enlarged radiographs than with standard technic, and the films are of proper density, with only minimal loss of contrast because of the high kilovoltage used.

The amount of radiation received by the patient during an exposure made with the magnification technic may be as high as three times that received in a standard examination if the kilovoltage is the same in both. With the higher kilovoltage (100 kv), our measurements indicate that the roentgen dose to the skin is identical with that delivered in a routine study at 66 kv and, in addition, the film densities are comparable. A value of approximately 6 milliroentgens was obtained by each method. This equalization of dosage may be explained by the greater penetration of the beam with the same exposure time.

ILLUSTRATIVE CASES

CASE 1: W. F., an 8-month-old female infant, was admitted to the University of Missouri Hospital for evaluation of a thoracic deformity present since birth. Physical examination showed a slightly underdeveloped infant with a marked pectus excavatum deformity of the sternum and with flaring of the costal margins. The respiratory rate was persistently rapid.

Fluoroscopy of the chest showed normal diaphragmatic movement without mediastinal shifting. On plain films the mediastinum was shown to be displaced to the right, with increased radiability of the left hemithorax (Fig. 1, A). There was a suggestion of some fine linear shadows in the left midlung field, and a roentgenogram of the chest made with magnification technic was obtained. This film dramatically demonstrated overexpansion of the left upper lobe, visualized the major interlobar fissure, and outlined an air-filled cyst in the left infrahilar region

(Fig. 1, B). These findings suggested cystic disease of the lung. Technically satisfactory bronchography failed to demonstrate the left upper lobe bronchus.

Thoracotomy was performed and the left upper lobe was found to be overexpanded, inelastic, and firm to palpation. Several cysts were present in this lobe. A left upper lobectomy was performed.

Pathologic examination of the excised tissue showed changes compatible with congenital cystic disease of lung.

CASE II: J. S., a 58-year-old white male, was admitted to the University of Missouri Hospital for evaluation of complaints referable to the hips, shoulders, and lower urinary tract. These symptoms were found to be due to degenerative arthritis and benign prostatic hypertrophy.

A chest film on admission showed generalized pulmonary emphysema and extensive linear and reticular densities throughout both lungs. In some of the areas of increased density there was a suggestion of calcification (Fig. 2, A). With magnification technic, the parenchymal densities were demonstrated to better advantage, with no evidence of calcification (Fig. 2, B). The infiltrates appeared to follow a vascular or bronchial distribution. Pulmonary fibrosis was suggested, possibly related to pneumoconiosis. Investigation into the patient's occupational history revealed a period of employment as a brickyard worker with chronic exposure to dust.

COMMENT

The advantages of the magnification technic in roentgenography of the chest in pediatric patients are obvious, being well illustrated by Case I. Relatively inconspicuous parenchymal densities in these small patients may become much more obvious when the image of the chest is magnified.

In the adult, the magnification technic provides the radiologist with an opportunity to study parenchymal lesions in more detail, to determine the patterns of distribution, the structure of the density, and the presence of minute calcifications. It is conceivable that with greater experience in applying this technic to patients with the type of disease now loosely classified as pulmonary fibrosis, some differential patterns may become evident which will aid in separating the many conditions which produce this nonspecific appearance.

Similar results may be obtained by photographic magnification of a roentgenogram. The latter process, however, is considerably more time consuming and therefore of little immediate value in roentgen interpretation. The technic described here has the advantage of being immediately available in the department of radiology without the use of photographic equipment.

CONCLUSIONS AND SUMMARY

Magnification of the roentgen image is useful for investigation of poorly defined parenchymal lesions in the chest. The method probably finds its greatest usefulness in pediatric roentgenography. The technic is described and illustrative cases are presented.

University of Missouri
Columbia, Mo.

REFERENCES

1. GILARDONI, A., AND SCHWARZ, G. S.: Magnification of Radiographic Images in Clinical Roentgenology and Its Present-Day Limit. Radiology **59**: 866–878, December 1952.

2. BAKER, C. D., LANE, F. E., AND PIRKEY, E. L.: Roentgen Examination of Old and New Trauma of the Spine with the Ultra-Fine Focus Roentgen Tube. Am. J. Roentgenol. **75**: 144–148, January 1956.

SUMMARIO IN INTERLINGUA

Technica De Magnification In Roentgenographia Thoracic

Le technica de magnification—restringite in le passato plus o minus completemente a studios skeletic—pote esser applicate con avantage al roentgenographia thoracic e es de valor particular in le investigation de mal-definite lesiones parenchymal. Le technica hic describite require le kilovoltage maximal permittite per le tabella del valores de tubos, 100 kv, pro obviar le plus longe tempore de exposition rendite necessari per le basse milliamperage del tubo a area focal de 0,3 mm. Es obtenite un magnification de 2×. Iste technica es specialmente utile con patientes pediatric.

Casos illustrative es presentate.

250-Kilovolt Chest Roentgenography

A Preliminary Report[1]

JOHN H. HARRIS, JR., M.D.,[2] WILLIAM J. TUDDENHAM, M.D.,[3] JOHN HALE, Ph.D., and EUGENE P. PENDERGRASS, M.D.

As a part of a general research program directed at increasing the accuracy of the roentgen diagnosis of chest neoplasms, very high voltage roentgenographic technics were explored. The most fruitful voltage range appeared from initial studies to be the 1 to 2-MEV region, and "supervoltage chest roentgenography" was proposed to permit the recording of diagnostic details of the mediastinum as well as of the pulmonary parenchyma in a single exposure (3, 4). While the value of such a procedure has been confirmed by recent studies (5), the cost and scarcity of supervoltage generators preclude its general adoption at present. It is the purpose of this report, therefore, to describe a technic employing a heavily filtered 250-kv. roentgen beam, which appears to be a useful and generally available substitute for supervoltage roentgenography.

The physical basis for the unusually great latitude which characterizes supervoltage roentgenograms is the fact that the absorption coefficient of bone approaches that of soft tissue for radiation of very high energy. Since absorption coefficients for radiation with a h.v.l. of 3 mm. Cu approach those for supervoltage radiation (h.v.l. 16 mm. Cu) (2, 6), it was thought worthwhile to explore with realistic phantom materials (1), and subsequently at a clinical level, the extent to which the advantages of megavoltage technics might be obtained with radiation produced by conventional deep therapy equipment.

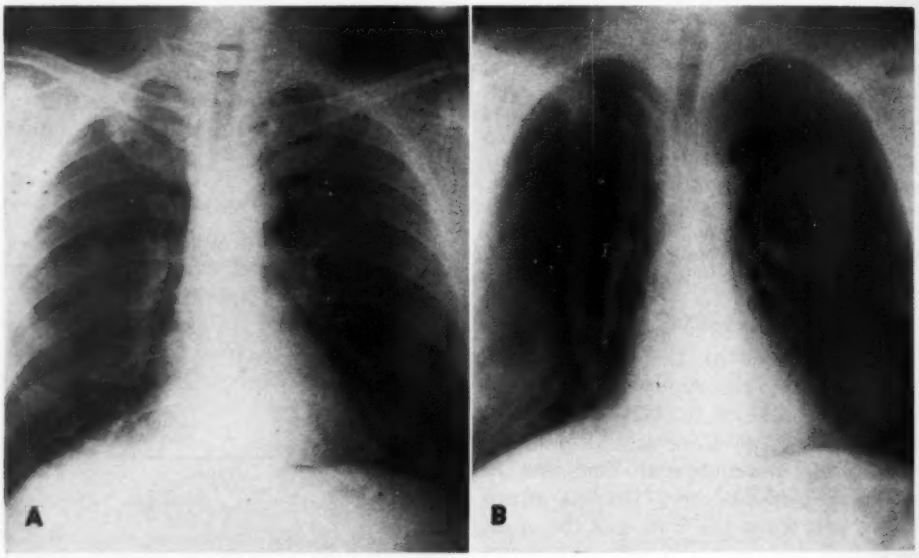


Fig. 1. Roentgenograms illustrating the relative visibility of a cavitating lesion in the right apex in conventional (A) and 250-kv (B) examinations. The lesion is obscured by a rib in the conventional study, but is clearly demonstrated on the 250-kv film. Note, too, the visibility of the tracheobronchial tree in the 250-kv examination.

A Standard X-ray Corporation 250-kv (constant potential) deep-therapy generator has been employed with an added filter of 0.4 mm. Sn + 0.25 mm. Cu + 1.0 mm. Al, resulting in radiation with a half-value layer of 3.3 mm. Cu. For posteroanterior chest roentgenograms on Kodak Industrial Film, Type AA, the exposure time has been adjusted to deliver a dose of 0.75 r(air) per exposure measured at the level of the posterior chest wall. For roentgenograms on Eastman No-Screen X-ray Film, an exposure dose of 0.5 r(air) has sufficed. In each instance the film has been enclosed in 0.005-in. lead-antimony intensifying screens.

Chest roentgenograms have been made of 23 selected patients with this technic, at a target-skin distance of 100 cm. The roentgenograms (Figs. 1

[1] From the Department of Radiology, Hospital of the University of Pennsylvania. This project was supported in part by a field investigation grant (CS 9255) from The National Cancer Institute, National Institutes of Health, Public Health Service.

[2] National Cancer Institute Fellow in Radiology.

[3] Scholar in Radiologic Research of the James Picker Foundation.

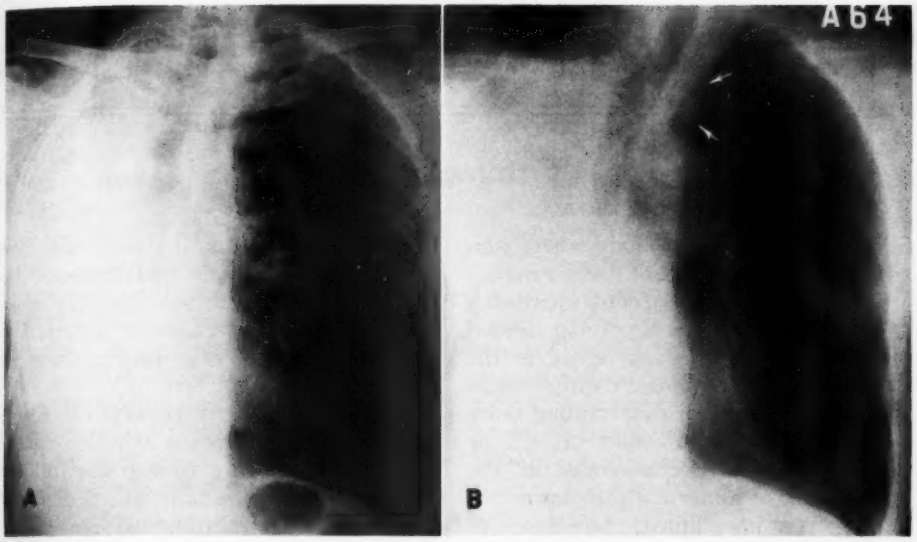


Fig. 2. Roentgenograms illustrating the relative visibility of a superior mediastinal mass in conventional (A) and 250-kv (B) examinations. The patient, a 64-year old white male, had had a pneumonectomy for carcinoma of the lung and returned complaining of the recent onset of hoarseness and dysphagia. Bronchoscopy revealed a mass, presumably recurrent carcinoma, encroaching on the lumen of the trachea just proximal to the level of the aortic arch. No evidence of the mass was noted in the conventional studies, but it is clearly demonstrated in the 250-kv roentgenogram (arrows).

and 2) are strikingly similar in appearance to supervoltage roentgenograms and, like them, have proved useful for the demonstration of lesions of the mediastinum, tracheobronchial tree, and areas of the pulmonary parenchyma that are obscured by overlying bone in conventional studies. Thus, it appears that 250-kv roentgenography is a useful and generally available substitute for supervoltage roentgenography.

The major limitation of a deep therapy apparatus for chest roentgenography is the low exposure dose output, because the unsharpness of motion is more likely to impair the diagnostic quality of the roentgen image than either focal-spot size[4] or film-grain size. Supervoltage generators are currently in production which have been designed to permit chest roentgenography with exposure times of 1/20 to 1/10 second, but, as mentioned earlier, the use of supervoltage units is restricted by their cost. Both technics require a higher patient radiation dose than conventional methods. The dose required for 250-kv roentgenography, however, is 25 to 50 per cent lower than that required with supervoltages.

Our experience with 250-kv roentgenography has been gratifying and is continuing. It is hoped that other radiologists will be encouraged to employ the method in the examination of parts such as the chest, where air contrast exists but lesions may be obscured by overlying bone in conventional roentgenography.

[4] Recent studies indicate that the effect of focal spot size and film grain size on the visibility of soft-tissue detail is imperceptible. These studies will be published in the near future.

REFERENCES

1. HARRIS, J. H., JR., TUDDENHAM, W. J., STANTON, L., GLAUSER, F., AND PENDERGRASS, E. P.: Radiology **67**: 805–813, December 1956.
2. SPIERS, F. W.: Brit. J. Radiol. **19**: 52–63, February 1946.
3. TUDDENHAM, W. J., HALE, J., AND PENDERGRASS, E. P.: Am. J. Roentgenol. **70**: 759–764, November 1953.
4. TUDDENHAM, W. J., GIBBONS, J. F., HALE, J., AND PENDERGRASS, E. P.: Radiology **63**: 184–190, August 1954.
5. TUDDENHAM, W. J.: [In] Proceedings of the Third National Cancer Conference. Philadelphia, J. B. Lippincott Co., 1957.
6. WACHSMANN, F.: Acta radiol. **32**: 145–158, 1949.

EDITORIAL

Orbitography

In various areas of the body where routine radiography has been of limited usefulness in definitive diagnosis, contrast studies have proved of value in supplying needed information. One of these areas is the orbit. Here conventional roentgenography has been of aid in determining bony changes and the localization of opaque foreign bodies, and occasionally in the demonstration of abnormal soft-tissue calcification. It has failed, however, to afford satisfactory visualization of the retrobulbar soft tissues. To supply this deficiency and to afford differentiation of the bulb and retrobulbar space, workers in recent years have employed various contrast agents to outline this area with greater clarity.

Among early investigators in this field were Gasteiger and Grauer, who injected air into Tenon's capsule in animals to visualize the posterior surface of the eyeball and the optic nerve. Subsequently Spackman employed this method for the localization of foreign bodies in cases of double perforation of the eyeball. During World War II, Scheie and Hodes used oxygen as a contrast medium to differentiate intraocular and extraocular foreign bodies, especially when these were multiple.

While most of the early work was concerned with foreign body localization, the more recent application of contrast study of the orbit has been for the detection of tumors and their secondary effects. In 1952, de Abreu reported demonstration of a mass in 8 cases of suspected orbital tumor. He combined air injection with tomography and was able to determine the size, configuration, and location of the neoplasms. Dubilier, von Gal, Freemond, and Evans employed the same technic in 12 cases of unilateral exophthalmos in which tumor was suspected. In 6 cases soft-tissue masses, including one pseudotumor, were demonstrated. Dubilier and his associates describe the technic of injection and subsequent roentgenography in their communication.

Bertelsen and Petersen have recently reported their experience with 8 cases in which they obtained tomograms following air injection. The air is injected into Tenon's capsule if the clinical signs point to a juxtabulbar tumor or involvement of the globe itself. If a retrobulbar lesion is suspected, the air is introduced into the retrobulbar space.

Opacifying media have also been employed to provide contrast radiography of the orbit, with varying degrees of success. The oily media have, however, proved to be so slowly absorbed that chronic inflammatory changes have been attributed to their use. Their distribution in the tissues has also tended to be uneven. Recent workers have experimented with water-soluble agents.

Manchester, Bonmati, Leigh, and Calhoun used Diodrast in their experimental studies, making the injection into the muscle cone, which is formed by the four rectus muscles as they leave the eye and converge posteriorly at the apex of the orbit. This they consider the optimum area for injection because of its central location and characteristic configuration. One cubic centimeter of the medium proved to be sufficient in rabbits, in which the orbit is about one-fifth the size of that in man. Hyaluronidase was found to increase the rapidity with which the medium was absorbed, but opacification was less satisfactory than with Diodrast alone.

In a recent communication, Lombardi reports his experience in 50 examinations in

man, in which a water-soluble contrast medium (Umbradil) was used, diluted with novocaine (1 ml.) and hyaluronidase (100 units dissolved in 1 ml. of distilled water), to produce an iodine concentration of 21 per cent. He quotes Cowie and Groves to the effect that the minimum concentration of iodine solution utilizable in orbitography is 17 per cent. Like Manchester and his associates, Lombardi injects the solution into the muscular conus. Among his 50 cases there were 15 technical failures; in 16 cases the findings were negative, and in 19 positive. Eleven primary tumors and 4 pseudotumors of the orbit were demonstrated; 4 cases had not been confirmed by operation. Complications were rare and disappeared without aftereffects in this series.

The technic of injection is said to be simple and safe in the hands of those accustomed to ophthalmologic surgery. Injection into the retrobulbar space is usually done through the temporal part of the lower eyelid, in an upward, medial, and backward direction to the posterior pole of the bulb. From 10 to 20 c.c. of air is introduced. Injection of Tenon's capsule is usually done with a curved needle, by the transconjunctival route through the fascia bulbi in the upper temporal quadrant at the attachment of the lateral rectus muscle.

Injection of the retrobulbar space usually produces emphysema of the eyelids, with a mild exophthalmos and with slight temporary discomfort. Injection of Tenon's capsule is accompanied by emphysema of the bulbar conjunctiva which may extend to the corneal limbus. In 2 cases described by Lombardi the opaque medium passed into the subdural spaces of the cranium, producing pain, vomiting and nausea. The symptoms disappeared after a few hours without aftereffects. Others report temporary disabilities after the use of a fluid medium. Complications following the introduction of air appear to be rare, although one case of air embolism causing temporary symptoms has been reported. Bertelsen and Petersen give as contraindications: (1) infections in the orbit and (2) suspected injury of the eyeball, as loss of the vitreous body may occur due to increased intrabulbar pressure.

This specialized examination is not one for routine use, but may prove to afford much needed and valuable information in selected cases. It is especially useful in the presence of unilateral exophthalmos where tumor is suspected and in following the progress of radiation therapy in such cases. Recent investigators would appear to favor pneumography, although the opaque media have their advocates. Complications are apparently few and of minor consequence. The technic of injection is specialized and, as suggested above, is best done by the ophthalmologic surgeon. As in other specialized examinations where surgical procedures are involved, teamwork is often the key to success.

REFERENCES

DE ABREU, M.: Orbital Emphysema. Am. J. Ophth. **35**: 1269–1272, September 1952.

BERTELSEN, T. I., AND PETERSEN, O.: Orbital Pneumography. Acta radiol. **47**: 426–432, June 1957.

COWIE, J. W., AND GROVES, J. S.: Preliminary Report on the Use of Contrast Media in Orbital Radiography. Brit. J. Ophth. **39**: 283–293, May 1955.

DUBILIER, W., JR., VON GAL, H., FREEMOND, A., AND EVANS, J. A.: Orbital Pneumotomography. Radiology **66**: 387–392, March 1956.

GASTEIGER, H., AND GRAUER, S.: Zur Diagnose der Doppelperforation des Augapfels mit Hilfe von Lufteinblasung in den Tenonschen Raum. Fortschr. a. d. Geb. d. Röntgenstrahlen **40**: 272–278, August 1929.

LOMBARDI, G.: Orbitography with Water-Soluble Contrast Media. Acta radiol. **47**: 417–425, June 1957.

MANCHESTER, P. T., JR., BONMATI, J., LEIGH, T. F., AND CALHOUN, F. P., JR.: Experimental Orbitography. Am. J. Roentgenol. **74**: 508–517, September 1955.

SCHEIE, H. G., AND HODES, P. J.: Injection of Oxygen into Tenon's Capsule. Arch. Ophth. **35**: 13–14, January 1946.

SPACKMAN, E. W.: X-Ray Diagnosis of Double Perforation of Eyeball After Injection of Air into Space of Tenon. Am. J. Ophth. **15**: 1007–1012, November 1932.

ANNOUNCEMENTS AND BOOK REVIEWS

AMERICAN ROENTGEN RAY SOCIETY

At the Fifty-eighth Annual Meeting of the American Roentgen Ray Society, Washington, D. C., Oct. 1–4, the following officers were elected to serve through 1957–58: President, Wendell G. Scott, M.D., St. Louis, Mo.; President-Elect, Barton R. Young, M.D., Germantown, Penna.; Secretary, C. Allen Good, M.D., Rochester, Minn.; Treasurer, Robert K. Arbuckle, M.D., Oakland, Calif.; Chairman of the Executive Council, Wilbur Bailey, M.D., Los Angeles, Calif.

The 1958 meeting will be held in Washington, D. C., Sept. 27–Oct. 3, in the Shoreham Hotel.

BROOKLYN RADIOLOGICAL SOCIETY

The Brooklyn Radiological Society, at a recent meeting, elected the following officers: President, Dr. Theodore Kamholtz; Vice-President, Dr. Harold Schwinger; Secretary-Treasurer, Dr. Solomon Schwartz, 555 Prospect Place, Brooklyn 38.

BUFFALO RADIOLOGICAL SOCIETY

The newly elected officers of the Buffalo Radiological Society are: President, Edward G. Rozek, M.D.; Vice-President, Glenn E. Jones, M.D.; Treasurer, Alfred Dobrak, M.D.; Secretary, Charles Bernstein, M.D., 685 Delaware Ave., Buffalo 9.

HAWAII RADIOLOGICAL SOCIETY

At a recent meeting of the Radiological Society of Hawaii, officers were elected for the coming year as follows: George W. Henry, M.D., President; Richard D. Moore, M.D., Vice-President; Junchu'an Wang, M.D., The Queen's Hospital, Honolulu 9, Secretary-Treasurer.

NEW YORK ROENTGEN SOCIETY

The President of the New York Roentgen Society for the current year is Maxwell H. Poppel, M.D.; the Secretary is Harold G. Jacobson, M.D., Montefiore Hospital, 210th St. and Bainbridge Ave., New York 67.

The Society meets on the third Monday of each month, October through April, at the New York Academy of Medicine. A late afternoon instruction hour, from 4:30 P.M. to 6:00 P.M., is followed by cocktails and dinner at 6:00 and a Residents' Quiz and the presentation of the evening at 8:00 P.M.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

Officers of the Rocky Mountain Radiological Society are: President, Angus K. Wilson, M.D., of Salt Lake City, Utah; President-Elect, George A Unfug, M.D., of Pueblo, Colo.; First Vice-President, John W. Walker, M.D., of Kansas City, Mo.; Second Vice-President, Jack W. Grossman, M.D., of Albuquerque, N. M.; Secretary-Treasurer, John H. Freed, M.D., 4200 East Ninth Ave., Denver 20, Colo.; Historian, H. Milton Berg, M.D., of Bismarck, N. D.

The next annual meeting of the Society will be held at the Shirley-Savoy Hotel in Denver, August 14–16, 1958.

SIXTH INTERAMERICAN CONGRESS OF RADIOLOGY

Attention is again called to the Sixth Interamerican Congress of Radiology which will be held in Lima, Peru, Nov. 2–8, 1958. Arne Jensen Travel, Inc., is the officially appointed travel agent for the Congress. Arrangements for transportation and hotel accommodations may be made through this agency, 9034 Sunset Blvd., Hollywood 46, California.

SEVENTH INTERNATIONAL CANCER CONGRESS, LONDON, 1958

Those planning to attend the Seventh International Cancer Congress, which will take place at the Royal Festival Hall, London, July 6–12, 1958, are reminded that enrollment forms must be received at the Congress office, 45 Lincoln's Inn Fields, London, W. C. 2, England, by Jan. 1, 1958, if a late fee is not to be incurred. Registration forms may be obtained from the Secretary-General at that address.

COURSE IN RADIOACTIVE ISOTOPES

The New York University Post-Graduate Medical School Department of Radiology is offering for the first time an intensive course in radioactive isotopes under the direction of Dr. Sidney Rubenfeld. The course may be entered the first of any month during the academic year and is designed to be of special interest to internists, radiologists, and hematologists. Tuition for the course is $150.

Further information may be obtained from the Office of the Associate Dean, New York University Post-Graduate Medical School, 550 First Ave., New York 16, N. Y.

COURSE IN RADIOLOGY UNIVERSITY OF KANSAS

The postgraduate course in Radiology, offered annually by the University of Kansas School of Medicine, will be held Feb. 10–13, 1958. The faculty will include Richard Chamberlain, M.D.,

Milton Friedman, M.D., David Gould, M.D., Averill Liebow, M.D., Robert Miller, M.D., Harvey M. Patt, Ph.D., William Stronach, Frederic Templeton, M.D., Dale Trout, D.Sc., and M. H. Wittenborg, M.D. The meeting is sponsored by the Radiological Society of Greater Kansas City, the radiologists of Kansas, and the University of Kansas School of Medicine. For further information, address the Department of Postgraduate Medical Education, Kansas City 12, Kans.

JAMES PICKER FOUNDATION AWARDS IN RADIOLOGICAL RESEARCH

On behalf of the James Picker Foundation, the National Academy of Sciences—National Research Council announces the continued availability of funds in support of radiological research. As in previous years, three specific types of support are offered: Grants-in-aid, Grants for Scholars, and Fellowships in Radiological Research(See Radiology **69:** 282, August 1957; 584, October 1957).

Applications in these three categories for the fiscal year 1958–1959 should be submitted by Dec. 1, 1957. Further details and application blanks may be obtained from the Division of Medical Sciences, Room 309, National Academy of Sciences—National Research Council, 2101 Constitution Ave., N.W., Washington 25, D. C.

COLLEGE OF RADIOLOGISTS OF AUSTRALASIA

In June 1957 there appeared the first issue of a new biannual radiological publication, the *Proceedings of the College of Radiologists of Australasia.* The scope of this new periodical is outlined by the President of the College in a brief foreword:

"The College of Radiologists of Australasia is a young College and its members are relatively few. They are spread thinly over this continent and New Zealand. Because of the great distances separating the larger cities where our Annual Meetings are held, it is impossible for the majority of our members to attend these meetings. Each year, excellent papers are read. This journal is established with the primary object of publishing these and other papers and of keeping all members informed of our 'Proceedings.' It will be, for many of our members, their only means of communication with their fellows. It will provide an avenue of expression for Australasian radiologists and will encourage them to do and to publish original work in their particular fields of interest."

Papers appearing in the new journal will be abstracted in due course in RADIOLOGY.

ATOMS FOR PEACE AWARD

Presentation of the first $75,000 Atoms for Peace Award was made to Professor Niels Bohr, 72-year-old Danish scientist, during a special convocation at the National Academy of Sciences in Washington on Oct. 24. The presentation was made by Mr. William Clay Ford, representing Mr. Henry Ford, II. Dr. Arthur H. Compton of Washington University, St. Louis, and Prof. J. A. Wheeler of Princeton University addressed the Convocation.

This award is the first of ten to be granted to those persons, anywhere in the world, who have made the greatest contributions to the peaceful uses of atomic energy. The awards were created in 1955 as a memorial to Henry Ford and Edsel Ford. The sum of $1,000,000 was designated for this purpose by the Ford Motor Company Fund.

NEW GENERAL MANAGER GENERAL ELECTRIC X-RAY DEPARTMENT

Lyman R. Fink, Ph.D., has been appointed General Manager of General Electric's X-Ray Department, effective Sept. 1. Dr. Fink joined General Electric in 1937 and since June of 1955 has been manager of research application at the Research Laboratory in Schenectady, N. Y.

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

MEDICAL RADIATION BIOLOGY. By FRIEDRICH ELLINGER, M.D., Chief Radiation Biologist and Head Pharmacology Division, Naval Medical Research Institute; Member Radioisotope Board and Consultant to the Tumor Board, U. S. Naval Hospital, Bethesda, Maryland. A volume of 946 pages, with illustrations. Published by Charles C Thomas, Springfield, Ill., 1957. Price $20.00.

ADVANCES IN RADIOBIOLOGY. PROCEEDINGS OF THE FIFTH INTERNATIONAL CONFERENCE ON RADIOBIOLOGY HELD IN STOCKHOLM ON 15TH–19TH AUGUST, 1956. Edited by GEORGE CARL DE HEVESY, ARNE GUNNAR FORSSBERG, AND JOHN D. ABBATT. A volume of 504 pages, with numerous figures and tables. Published by Charles C Thomas, Springfield, Ill., 1957.

EFFECT OF RADIATION ON HUMAN HEREDITY. REPORT OF A STUDY GROUP CONVENED BY WHO TOGETHER WITH PAPERS PRESENTED BY VARIOUS MEMBERS OF THE GROUP. A monograph of 168 pages, with charts and tables. Published by World Health Organization, Palais des Nations, Geneva, Switzerland, 1957. Distributed in the United States by Columbia University Press, New York 27, N. Y. Price $4.

THE YEAR BOOK OF CANCER (1956–1957 YEAR BOOK SERIES). Compiled and edited by RANDOLPH LEE CLARK, JR., B.S., M.D., M.Sc. (Surgery), D.Sc. (Hon.), Houston, Texas, Director and Surgeon-in-Chief, The University of Texas M.D. Anderson Hospital and Tumor Institute; Professor of Surgery, The University of Texas Postgraduate School of Medicine; Clinical Professor of Surgery, Baylor University College of Medicine; Fellow, American College of Surgeons, and RUSSELL W. CUMLEY, B.A., M.A., Ph.D., Houston, Texas; Director of Publications, The University of Texas M.D. Anderson Hospital and Tumor Institute; Professor of Medical Journalism, The University of Texas Postgraduate School of Medicine. A volume of 572 pages, with 210 figures. Published by the Year Book Publishers, Inc., Chicago 11, Ill., 1957. Price $7.50.

THE MEDICAL ANNUAL. A YEAR BOOK OF TREATMENT AND PRACTITIONERS' INDEX. SEVENTY-FIFTH YEAR 1957. Editors: SIR HENRY TIDY, K.B.E., M.A., M.D. (Oxon.), F.R.C.P., and R. MILNES WALKER, M.S. (Lond.), F.R.C.S. A volume of 570 pages, with numerous figures and tables in addition to 52 plates. Published by John Wright & Sons, Ltd., Bristol, England; the Macmillan Company of Canada, Ltd., Toronto, Canada, 1957.

SELECTED PAPERS FROM THE INSTITUTE OF CANCER RESEARCH: ROYAL CANCER HOSPITAL AND FROM THE ROYAL MARSDEN HOSPITAL, 1955. Published by order of the Committee of Management of the Institute and the Board of Governors of the Royal Marsden Hospital, London. Volume 10. A volume of 808 pages, with figures and tables. Printed by the Replika Process in Great Britain by Lund Humphries, London, England, 1957.

IV CONGRESSO MEDICO DOS RADIOLOGISTAS E ELECTROLOGISTAS DE CULTURA LATINA, 8 A 13 DE ABRIL DE 1957, LISBOA. CONFERÊNCIAS E RELATÓRIOS. VOLUMES I E II. Two volumes of 410 and 360 pages, with figures and tables. Articles in French, Italian, Spanish, and Portuguese. Published by Dagra S. A., Diemen, Netherlands; Gevaert Film, Anvers, Belgium; Printed by Oficinas Gráficas de Bertrand (Irmãos), Ltda., Travessa da Condessa do Rio, 7, Lisbon, Portugal, 1957.

DIE VASKULÄREN ERKRANKUNGEN IM GEBIET DER ARTERIA VERTEBRALIS UND ARTERIA BASIALIS. EINE ANATOMISCHE UND PATHOLOGISCHE, KLINISCHE UND NEURORADIOLOGISCHE STUDIE. By H. KRAYENBÜHL, Professor für Neurochirurgie, Direktor der neurochirurgischen Universitätsklinik Zürich, and M. G. YAŞARGIL, Assistent der neurochirurgischen Universitätsklinik Zürich. Fortschr. a. d. Geb. d. Röntgenstrahlen, Ergänzungsband 80. A volume of 170 pages, with 205 illustrations (mostly roentgenograms) and many tables. Published by Georg Thieme Verlag, Stuttgart, Germany, 1957. Distributed in the United States and Canada by the Intercontinental Medical Book Corporation, New York 16, N. Y. Price DM 77.—($18.35)

DIE HEUTIGE BEHANDLUNG DER SKELETT-TUBERKULOSE DES KINDES UND DES JUGENDLICHEN. By Dr. GEORG GOLGOWSKI, Wissenschaftlicher Oberassistent an der Orthopädischen Klinik München. With a Foreword by Prof. Dr. Max Lange, München. Tuberkulose-Bücherei, Monographien zur Monatsschrift "Der Tuberkulosearzt." A monograph of 62 pages, with 54 roentgenograms. Published by Georg Thieme Verlag, Stuttgart, Germany, 1957. Distributed in the United States and Canada by Intercontinental Medical Book Corporation, New York 16, N. Y. Price DM 12.—($2.85)

LITHIASE DE LA VOIE BILIAIRE PRINCIPALE. By PABLO-L. MIRIZZI, Professeur à l'Université de Cordoba, Argentine. A monograph of 162 pages, with 79 figures. Published by Masson & Cie, 120, Boulevard Saint-Germain, Paris 6e, France, 1957. Price 2,200 francs.

LA RADIOLOGIE PLEURO-PULMONAIRE. By Dr L. BABAIANTZ, Professeur à la Faculté de Médecine de Lausanne, and Dr F. CARDIS, Chargé de cours a la Faculté de Médecine de Lausanne. Preface by Dr E. Rist. Collection "Savoir interpréter," edited by Prof. agrégé H. Gounelle, No. 9. A monograph of 96 pages, with 50 figures. Published by Les Editions de Visscher S.P.R.L., 65, Avenue du Golf, Rhode-St-Genese, Brussels, Belgium, 1956. Price 75 Belgian francs.

IL PNEUMORETROPERITONEO NELLA DIAGNOSTICA DELLA PATOLOGIA SOTTODIAFRAMMATICA, CON PARTICOLARE RIGUARDO PER LO STUDIO DEI TUMORI. By L. ROSSI and A. BARONCHELLI. A monograph of 220 pages, with 211 illustrations. Published by Cappelli, Bologna, Italy, 1956. Price 4,000 lire.

Book Reviews

THE SALIENT POINTS AND THE VALUE OF VENOUS ANGIOCARDIOGRAPHY IN THE DIAGNOSIS OF THE CYANOTIC TYPES OF CONGENITAL MALFORMATIONS OF THE HEART: A TEN YEAR STUDY OF 421 ANGIOCARDIOGRAMS DONE ON 283 PATIENTS. By BENJAMIN M. GASUL, M.D., GERSHON HAIT, M.D., ROBERT F. DILLON, M.D., and EGBERT H. FELL, M.D. A volume of 80 pages, with 42

figures and 4 tables. Published by Charles C Thomas, Springfield, Ill., 1957. Price $3.50.

Within the space of 80 pages the authors of this modest work have furnished an atlas of venous angiocardiography which can be recommended as a compact summary of this procedure. The conditions are considered under three headings: Group 1, made up of congenital anomalies which *can almost always be diagnosed* from a technically good angiocardiogram; Group 2, including entities in which the diagnosis *can usually be made* by this means; Group 3, in which the diagnosis *can usually not be made* angiocardiographically. A fourth group in which additional studies are *always required* is not discussed.

The heart lesions are illustrated by reproductions of angiocardiograms, 4 × 4 1/4 inches, which range in quality from excellent to fair. The fundamental physiologic changes in each condition are briefly presented, with little attention to smaller anatomical details. Each of the entities discussed is introduced by a brief summary of the anatomic defects and hemodynamics, illustrated by a full-page schematic drawing.

TUMORS OF THE KIDNEY, RENAL PELVIS AND URETER. By BALDUIN LUCKÉ, M.D., Dr.P.H., Late Professor of Pathology, University of Pennsylvania, Philadelphia, Penna., and HANS G. SCHLUMBERGER, M.D., Professor of Pathology, Ohio State University, Columbus, Ohio. Atlas of Tumor Pathology. Section VIII—Fascicle 30. A volume of 210 pages, with 190 illustrations and 9 tables. Published by the Armed Forces Institute of Pathology, under the Auspices of the Subcommittee on Oncology of the Committee on Pathology of the Division of Medical Sciences of the National Academy of Sciences—National Research Council, Washington, D. C., 1957. For sale by the American Registry of Pathology, Armed Forces Institute of Pathology, Washington 25, D. C. Price $2.25.

This scholarly combination of treatise and atlas, although of moderate length, is complete. Starting with tumors of the renal capsule and the six heteroplastic tissues in the kidney, tumors of the renal parenchyma, the renal pelvis, and the ureter are thoroughly explored. Roentgenologists and pathologists will both be pleased with the authors' presentation of forty tumors of the kidney and twelve tumors of the ureters, profusely illustrated by photographs of the gross specimens, urograms, pyelograms, and photomicrographs, accompanied by descriptions of the gross and microscopic pathology, histogenesis, natural history, and prognosis, in the same learned and impressive style that Dr. Schlumberger employs in his lectures. The modest price is no proper clue to the extensive coverage of this field.

TUMORS OF THE PITUITARY GLAND AND INFUNDIBULUM. By JAMES W. KERNOHAN, M.D., Chairman, Sections of Pathologic Anatomy and Surgical Pathology, Mayo Clinic, Rochester, Minn.; Professor of Pathology, Graduate School, University of Minnesota, Minneapolis, Minn., and GEORGE P. SAYRE, M.D., Section of Pathologic Anatomy, Mayo Clinic, Rochester, Minn.; Assistant Professor of Pathology, Graduate School, University of Minnesota, Minneapolis, Minn. Atlas of Tumor Pathology. Section X—Fascicle 36. A volume of 84 pages, with 74 illustrations and 3 tables. Published by the Armed Forces Institute of Pathology under the Auspices of the Subcommittee on Oncology of the Committee on Pathology of the Division of Medical Sciences of the National Academy of Sciences—National Research Council, Washington, D. C., 1956. For sale by the American Registry of Pathology, Armed Forces Institute of Pathology, Washington 25, D. C. Price $1.00.

This important work adds significantly to the classical contributions of Cushing and Bailey to our knowledge of pituitary tumors. It is based on a large practical experience in the pathology, treatment, and results of treatment of pituitary chromophobe, eosinophilic and basophilic adenomas, as well as hypopituitarism not associated with primary tumors of the gland. In the latter category are meningiomas, granulomas, carcinomas, adamantinomas, and parapituitary epidermoid tumors. The trend in recent years to use roentgen therapy first in the treatment of patients with pituitary tumors and to resort to surgical intervention only if this fails, with appropriate supplemental endocrine therapy, is duly noted.

X-RAY CHART OF THE HUMAN SKELETON. Originally devised by the late Dr. RUDOLPH GRASHEY, translated, revised, and augmented by more than 80 new entries by GERHART S. SCHWARZ, M.D., Assistant Professor of Radiology, College of Physicians and Surgeons, Columbia University, New York, N. Y. A chart, 28 × 44-in., depicting the skeleton at 3/5 natural size. Published by Stechert-Hafner, Inc., 31 East 10th St., New York 3, N. Y., 1957. Price $5.25.

This is a revised skeletal chart based on the chart originated more than twenty years ago by Rudolph Grashey, which has gone through several editions in Germany. Dr. Schwarz, using the first German edition as a basis, has added about 80 new entries and has reversed the tonal values so that the bones appear white on a black background.

DIE PROGNOSE DER WIRBELSÄULENLEIDEN. EINE BERUFSPROPHYLAKTISCHE BETRACHTUNG. By PROF. DR. J. E. W. BROCHER, Geneva. A monograph of 68 pages, with 45 illustrations on 33

figures. Published by Georg Thieme Verlag, Stuttgart, Germany, 1957. Distributed in the United States and Canada by Intercontinental Medical Book Corporation, New York 16, N. Y. Price DM 12.80 ($3.05).

This short monograph concerns the occupational aspects of disorders of the spinal column, with particular emphasis upon pre-employment evaluation. The author offers suggestions on history taking, physical examination, and roentgen evaluation with the object of predicting which individuals are likely to develop lumbago, sciatica, and other incapacitating disorders and assigning to jobs involving a heavy load on the spine only those suited to such work.

Proper evaluation of the vertebral column is becoming more and more important, not only because of the heavy expense to the employer when a worker becomes invalided as the result of a painful back, but also because of the individual himself. At the present time the best hygienic practice calls for the acceptance of only the strongest and best developed for those jobs which involve back strain. This is not totally unfair, since developmental weaknesses are prone to become apparent between the ages of thirty-five and forty. The man who finds himself disabled because of a disorder of the spine is either retired prematurely, placed on welfare, or forced into another and frequently unsuitable occupation. A chronic back ailment means for the bearer a social descent.

The most careful examination must be done between the ages of fifteen and twenty-five. For the younger persons in this age group, occupational guidance is of equal importance, since it is useless for an individual with pre-existing disease to attempt an occupation requiring heavy labor. Scheuermann's disease receives great emphasis in this connection. Degenerative changes are handled intelligently, with particular emphasis on the early involvement of the lumbosacral or of the fourth lumbar intervertebral disk. Following this, the author separates those developmental anomalies which are significant from those which are of no consequence. Those more severe disorders which should lead to an immediate rejection of either a military recruit or an applicant for heavy work are briefly discussed.

This pamphlet should be translated and distributed to industrial physicians concerned with vocational guidance and pre-employment examinations. It will provide insight into the European attitude toward the patient with a predisposition to spinal weakness. To the practicing radiologist the work is of only general interest. The roentgenograms have appeared in large part in previous publications, many being taken from Brocher's book on tuberculosis of the spine. Nothing new is offered in terms of diagnosis.

LA PNEUMOPELVIGRAFIA NELLA DIAGNOSI DEI TUMORI GINECOLOGICI. By G. CARNEVALI, U. LUCARELLI, AND P. PARACCHI. Prefaces by Professors P. Rondoni, F. Perussia, and P. Natale. From the Istituto di radiologia dell'Università di Milano, and the Istituto nazionale per lo studio e la cura dei tumori di Milano. A volume of 198 pages, with 64 figures. Published by Casa editrice Renzo Cortina, Pavia, Italy, 1957.

Contrast visualization of the uterus can be achieved in the negative (diagnostic pneumoperitoneum, pneumogynecography), in the positive (hysterosalpingography), or by a combination of both (pelvigraphy). This does not exhaust the potential semantic variations in nomenclature (pneumopelvigraphy, double contrast gynecography, etc.). The method is certainly useful in the study of internal female organs. In this country the positive contrast procedure is widely employed, but there are relatively few who would induce a diagnostic pneumoperitoneum for this (or for any other) purpose. In their text the authors furnish in atlas form a cross-section of what the procedure can provide in the way of diagnostic possibilities in connection with utero-ovarian tumors. Most of the cases included were proved by surgery and/or autopsy. A small drawing, accompanying each roentgenogram, is helpful in the interpretation of the described findings. The print and the reproductions are excellent. The monograph is recommended to those interested in acquiring a basic knowledge of the method.

RADIOLOGIE CLINIQUE DE L'ESTOMAC OPÉRÉ. By P. PORCHER, Médecin Radiologiste de l'Hôpital Saint-Antoine et de l'Hôpital Américain, Membre de l'Académie de Chirurgie, and P. BUFFARD, Médecin Radiologiste des Hôpitaux de Lyon, with the collaboration of R. GUILLET, Professeur agrégé de Chirurgie de la Faculté de Médecine de Lyon, and CL. COUINAUD, Assistant de Chirurgie des Hôpitaux de Paris. Preface by F. Moutier. A volume of 660 pages, with 507 figures. Published by Masson & Cie, Editeurs, 120, Boulevard Saint-Germain, Paris, 6e, 1957. Price 7,200 francs (paper bound); 8,000 francs (cloth).

Most general diagnostic roentgenologists are well aware of the difficulties of accurate diagnosis in the roentgen examination of the stomach after surgery. In order to do an adequate examination, one must be aware of the type of operation performed and of the possible disturbances which may occur after the various procedures.

Any postoperative patient who vomits or bleeds, or in whom it may be suspected that the sutures are inadequate, or who presents clinical signs of local or general peritoneal reaction, should be examined as an "urgent abdomen," and should be treated with

precautions which include a minimum of active mobilization, short fluoroscopy time, and multiple roentgenograms in multiple positions.

The use of morphine to enhance peristalsis is suggested as an aid in the examination. Where practical, the advantages of image amplification and cineroentgen studies are discussed.

The first major section of this French text deals with the methods of examining the stomach after various operations. The second major section concerns the complications common to the several types of intervention, including early postoperative complications, postoperative peptic ulcer, gastritis and jejunitis, recurrence of ulcers and cancers, occurrence of cancer in the postoperative stomach, obstacles to gastrointestinal transit, syndrome of the afferent loop, the dumping syndrome, and various functional disturbances.

The third major section covers gastroesophageal relations after resection of the esophagus or gastric fundus and operations which involve the biliary system and the pancreas. A fourth section deals with early postoperative complications of gastric surgery.

The monograph is well illustrated by means of diagrams to explain the various surgical procedures and by reproductions of roentgenograms to demonstrate the pathologic changes described. The subject is a difficult one and the authors do a commendable job in organizing and presenting their material.

IN MEMORIAM

SYDNEY JAMES HAWLEY, M.D.

1899-1957

On July 28, 1957, by the death of Sydney Hawley, many of us lost a good friend and the Radiological Society of North America found itself without a President-Elect. Society officers can be replaced, but friends cannot. To write the obituary of a friend is a difficult task; yet who else should undertake it?

Sydney James Hawley was born in Seattle on

Sept. 28, 1899, and grew up in that city, obtaining his basic education in the public schools and the University of Washington. During his college years he became a member of the Phi Kappa Psi fraternity. On receipt of his B.S. degree, he went to the University of Pennsylvania to study medicine, being awarded his M.D. in 1924. Following an internship at the Geisinger Hospital, in Danville, Pennsylvania, he returned to Philadephia to study roentgenology with Dr. Willis Manges, at the Jefferson Hospital. In 1927 he went back to the Geisinger Hospital as roentgenologist, a post which he retained for nearly twenty years. However, his native Northwest had always attracted him, and in 1946 he returned to Seattle, where he carried on an extensive private practice in roentgenology until the time of his death.

On the occasion of his leaving Danville, the *Pennsylvania Journal of Radiology* dedicated an issue to "Sydney James Hawley, gentleman, scholar, author, scientist, poet, and musician"—the dedication is an epitome of all that was said in a series of tributes. Throughout the rest of his life he continued to live up to this characterization.

He made numerous scientific contributions to radiological journals. While his interests were in both diagnostic and therapeutic fields, he is perhaps best known for having reawakened in America an interest in rotation therapy. For a time he was "a voice crying in the wilderness," but developments in recent years have shown that he was a prophet indeed.

Dr. Hawley was a member of the Radiological Society of North America and of the American Roentgen Ray Society, and a Fellow of the American College of Radiology, as well as a member of local radiological organizations in Pennsylvania and in the Northwest. In the Radiological Society he was an active worker, as member of the Publication Committee from 1939 to 1946, as representative of the Society on the Board of Chancellors of the American College of Radiology from 1945 to 1949, as First and Second Vice-President in 1945 and 1950 respectively, and as a member of the Board of Directors from 1953 until his death. He became President-Elect in 1956. During his years in the Pennsylvania Radiological Society he was one of its most active members, being in a large measure responsible for the reputation developed by that organization for friendliness on the one hand and worthwhile programs on the other. In the Northwest he was active in promoting closer scientific and social cooperation between radiologists of Canada and the United States. Both in Danville and in Seattle he was deeply concerned with civic problems and community interests.

Yet Sydney will be remembered not so much for his professional and civic activities as for his outgoing personality. He never married, and the warmth that might have been expended on a family he lavished on his friends. A peerless storyteller, a gay companion in almost any venture, and a serious and sympathetic partner in many valuable projects, his equal will be difficult indeed to find.

EDITH H. QUIMBY, Sc.D.

LEWIS LAJOS HAAS, M.D.

1893–1957

Dr. Lewis Lajos Haas, Associate Professor of Radiology at the University of Illinois College of Medicine, was killed instantly on June 2, 1957, when struck by an automobile outside Quebec City, where he had been attending the American Radium Society meetings.

Dr. Haas was born in 1893 in Budapest, Hungary, received his degree in medicine from Pazmany Peter University and his specialty training at the University of Budapest. For many years he was head of the radiological department at Varosmajor Hospital and consultant at St. Stephen's City Hospital in Budapest. During World War II he was confined in concentration camps and was the only member of his family to survive. After the war he became head of the department of roentgenology at Koranyi City Hospital in Budapest and Associate Professor of Roentgenology at his alma mater. He came to the United States in 1948 on an international study mission organized for the rehabilitation of specialists who had been denied contact with their specialty during the war, and he never returned to Hungary.

Dr. Haas was a long-time member of the Hungarian Roentgen Society, twice its president, a correspondent member of the Austrian Roentgen Society, and the Hungarian representative to the International Committee on Radiological Units from 1937 to 1948. He was a member of the Chicago Medical Society and the Chicago Roentgen Society, and at the time of his death had applied for membership in the Radiological Society of North America.

Best known among Dr. Haas' writings are his detailed studies of skull films, particularly the sella area, his work on hypersensitivity to irradiation, and, more recently, his excellent contributions on the application of betatron x-ray and electron beams. His bibliography numbered more than 75 titles. Abstracts of European articles appeared regularly over his signature in RADIOLOGY and he was responsible for numerous reviews of German publications in that journal.

ROGER A. HARVEY, M.D.

ABSTRACTS OF CURRENT LITERATURE

ROENTGEN DIAGNOSIS

The Head and Neck

BULL, J. W. D., AND ROVIT, R. L. Radiographic Localization of Intracerebral Gliomata 763

RAVELLI, A., AND WINKLER, L. Extracranial Subperiosteal Epidermoid Cyst in the Frontal Bone 763

RANGER, I. An Experimental Study of Sialography, and Its Correlation with Histological Appearances, in Normal Parotid and Submandibular Glands 763

The Breast

GERSHON-COHEN, J., AND INGLEBY, HELEN. Roentgen Screening of Mammary Tumor Progression 764

The Chest

SÖVÉNYI, E., AND BENCZE, GG. Lung Changes in Systemic Lupus Erythematosus 764

LODIN, HERMAN. Roentgen Diagnosis of Pulmonary Mycoma 764

The Heart and Blood Vessels

NORDENSTRÖM, BJÖRN, ET AL. Controlled Puncture and Contrast Injection into the Left Ventricle of the Heart 764

BAUERSFELD, S. RICHARD, ET AL. Patent Ductus Arteriosus in Infancy 765

SOLOFF, LOUIS A., ET AL. Ebstein's Disease: Description of the Heart of the First Case Diagnosed During Life 765

VAN BUCHEM, F. S. P., AND EERLAND, L. D. Myxoma Cordis. Diagnosis Established Pre-Operatively; Surgical Removal of the Tumour 765

ROBERTS, H. J. The Clinical Problem of Adiposity of the Heart and Cardiac Enlargement of Undetermined Etiology 766

STEINBERG, ISRAEL. Diagnosis of Congenital Aneurysm of the Ventricular Septum During Life 766

WRIGHT, WALTER D., AND NIEBAUER, JOHN J. Congenital Heart Disease and Scoliosis 766

HEATH, DONALD, ET AL. Idiopathic Pulmonary Hypertension 766

EVANS, WILLIAM, ET AL. Solitary Pulmonary Hypertension 767

JOHNSON, JOHN B., ET AL. Thoracic Aortography 767

KAYE, JOSSE, ET AL. Aortography with Simultaneous Bilateral Arteriography of the Lower Extremities 767

MAVOR, G. E. Diagnosis of Traumatic Main-Vessel Thrombosis 768

STEINER, R. E., ET AL. Percutaneous Splenic Portal Venography 768

BERGSTRAND, I., AND EKMAN, C.-A. Portal Circulation in Portal Hypertension 768

The Digestive System

PIAZZA, GIOVANNI. Pseudodiverticular Dyskinesia of the Esophagus 769

MARSHAK, RICHARD H., AND ELIASOPH, JOAN. Cardiospasm or Carcinoma? The Roentgen Findings 769

PRÉVÔT, R. Transient Invaginations of the Gastrointestinal Tract 769

KLEIN, MICHAEL M., AND BRADLEY, ROBERT L. Gastric Ulcer in the Older Age Group 770

FLANNERY, M. G., AND CASTER, MILTON P. Hemangioma of the Stomach with a Roentgenologic Diagnostic Point 770

CRONE, R. S., AND ARDRAN, G. M. Effect of Morphine Sulfate on Gastric Motility. Some Radiologic Observations in Man 770

DEFEO, EDWARD, AND MEIGHER, STEPHEN C. Gallstones Impacted in the Stomach and Duodenal Bulb Demonstrated by Roentgenologic Examination 771

LESZLER, A. Jejunogastric Intussusception as a Rare Complication Following Gastric Surgery 771

SAMUEL, ERIC. The Gas-Filled Appendix 771

MACARINI, N., AND OLIVA, L. New Methods of Demonstration of the Pancreas 771

CULVER, GORDON J., ET AL. Relationship of Stenosis to Rokitansky-Aschoff Sinuses of the Gallbladder 771

JONES, GLENN M., AND CAYLOR, HAROLD D. Anomalous Termination of Common Duct .. 772

OLANDER, GEORGE A., AND DEAN, GERALD S. Benign Tumor of Cystic Duct Producing Symptoms of Chronic Cholecystitis 772

COHN, EDWIN M., ET AL. Cholecystography in the Presence of Jaundice 772

HOFFMANN, C. ROWELL. Phototimed Erect Compression Spot Films in Cholecystography 772

HOERR, STANLEY O. Operative Cholangiography via the Cystic Duct 773

The Diaphragm

ROCHE, G., ET AL. Diaphragmatic Pleurisy or Phrenic Paralysis? 773

The Musculoskeletal System

DE REUS, H. D. The Osseous Infarct 773

HILTEMANN, H. Periostitis Ossificans in Rheumatic Polyarthritis in Children 773

ROTCH, THOMAS M., AND GEORGE, ARIAL W. A Study of the Early Conditions of Osteomyelitis in Young Children by the Röntgen Ray 774

SCHOBINGER VON SCHOWINGEN, ROBERT. Primary Reticulum-Cell Sarcoma of Bone 774

ZAK, FREDERICK G., ET AL. Osseous Lesions in Urticaria Pigmentosa 774

KULOWSKI, JACOB. Roentgenologic Aspects of Motor Vehicle Accidents 774

FRIES, JOHN W. Roentgen Features of Fibrous Dysplasia of the Skull and Facial Bones. Thirty-Nine Proved Cases. 775
SCHNEIDER, RICHARD C., AND KAHN, EDGAR A. Chronic Neurological Sequelae of Acute Trauma to the Spine and Spinal Cord. Significance of the Acute-Flexion or "Tear-Drop" Fracture-Dislocation of the Cervical Spine. 775
PECK, FREMONT C., JR. A Calcified Thoracic Intervertebral Disk with Herniation and Spinal Cord Compression in a Child. 775
BAUER, DONALD DEF., AND HARRIS, NORMAN M. Annulo-Meningeal Interval. 776
ANDERSON, CARL E. Spondyloschisis Following Spine Fusion. 776
NAUDIN, E. P., AND GIRARD, P. F. Malformations of the Occipitovertebral Joint. 776
REGEN, EUGENE M., AND HABER, ARNOLD. Giant-Cell Tumor of Cervical Vertebra with Unusual Symptoms. 776
ARKIN, ALVIN M., AND KATZ, JACOB F. Effects of Pressure on Epiphyseal Growth. Mechanism of Plasticity of Growing Bone. 776
SIFFERT, ROBERT S. Effect of Staples and Longitudinal Wires on Epiphyseal Growth. An Experimental Study. 777
BLAIR, JOHN D., AND WELLS, PAUL O. Bilateral Undescended Scapula Associated with Omovertebral Bone. 777
SAVCHUCK, WILLIAM B. Effects of Strontium and Fluoride on Repair of Unreduced Humeral Fractures in the Adult Rat. 777
SEIDENSTEIN, HAROLD. Two Unusual Dislocations at the Wrist. 778
LENTINO, WALTER, ET AL. The Carpal-Bridge View for Diagnosis of Abnormalities in the Dorsum of the Wrist. 778
FRISCHKNECHT, W. Early Diagnosis and Pathogenesis of Congenital Dislocation of the Hip 779
MARCH, HERMAN C., ET AL. Hypercholesteremic Xanthomata of the Tendons. 779

The Spinal Cord

CARAM, PEDRO C., ET AL. Intradural Lipomas of the Spinal Cord, with Particular Emphasis on the "Intramedullary" Lipomas. 779

Gynecology and Obstetrics

DE VILLIERS, P. D., AND BRINK, DONALD. Aortography: The Safest Means of Placental Localization?. 780

The Genitourinary System

DAMANSKI, M., AND KERR, A. SUTCLIFFE. Value of Cysto-Urethrography in Paraplegia. 780
CATEL, W., AND GARSCHE, R. The Image Amplifier in Pediatric Studies: Motility and Emptying Activity of the Kidney Pelvis and Calyces. 780

Miscellaneous

NÄGELE, E. Roentgen Findings in Progressive Scleroderma. 781
MINNO, ALEXANDER M., AND ROGERS, JAMES A. Ochronosis: Case. 781
LEFKOVITS, AARON M. Fatal Air Embolism During Presacral Insufflation of Air. 782

RADIOTHERAPY

VON SAAL, HERMAN, AND DALICHO, WILHELM A. Early Reports on Roentgen Therapy Combined with Local Application of Oxygen in Skin Tumors. 782
MIESCHER, GUIDO. Clinical Aspects and Therapy of Melanoma. 782
VONESSEN, A. Therapy of Melanoma. 783
DOHAN, F. C., ET AL. Roentgen Therapy in Cushing's Syndrome without Adrenocortical Tumor. 783
WATSON, T. A. Results of Treatment of Cancer of the Breast. 784
CHU, FLORENCE C. H. Results of Treatment of Ovarian Cancer with One Million Volt X-Ray 784
WHITTLE, R. J. M. Tumours of the Testicle. . . . 784
MARTIN, JAMES A., AND CONNOR, ROBERT B. Treatment of Malignant Effusions. 785
NICHOLS, DEAN, ET AL. Lymphosarcoma. Five Year Survivals with X-Ray Therapy. 785
KERSLEY, G. D. Radiotherapy in Arthritic Conditions. 786
MORRISON, ROBERT. Radiotherapy of the Rheumatic Diseases. Results of X-Ray Treatment of Ankylosing Spondylitis. 786
STOLL, BASIL A. Ankylosing Spondylitis: Its Hormonal Background in Relation to X-Ray Therapy. 786
NORIN, TORSTEN. Roentgen Treatment of Myeloma with Special Consideration to the Dosage. 786
LEVIN, ERWIN, ET AL. Observations on Value of Gastric Irradiation in Duodenal Ulcer. 787
SCHINZ, H. R. Experiences with the 31-MEV Betatron and Its Further Development to the Asklepitron 787
HAAS, LEWIS L., AND SANDBERG, GLEN H. Modification of the Depth Dose Curves of Various Radiations by Interposed Bone. 787

RADIOISOTOPES

OLINER, LEO, ET AL. Thyroid Function Studies in Children: Normal Values for Thyroidal I^{131} Uptake and PBI^{131} Levels. 788
SLINGERLAND, D. WARD. Effects of an Organic Iodine Compound (Priodax) on Tests of Thyroid Function. 788
NEWMAN, STANLEY, AND CUPP, CLAUDE M. Influence of Iodoalphionic Acid (Priodax), With and Without Thyrotropin, on Thyroidal I^{131} Uptake in Euthyroid Patients. . . . 789

MACK, ROBERT E., ET AL. Management of Carcinoma of the Thyroid 789
RUBINSTEIN, HERBERT M., AND OLINER, LEO. Myxedema Induced by Prolonged Iodide Administration 789
HAMOLSKY, MILTON W., ET AL. The Thyroid Hormone-Plasma Protein Complex in Man. II. A New in Vitro Method for Study of "Uptake" of Labelled Hormonal Components by Human Erythrocytes 790
BERES, PAUL, ET AL. Use of I^{131} Triolein in the Study of Absorptive Disorders in Man 790
MCKENNA, R. D., ET AL. Use of I^{131} Labeled Fat in the Study of Fat Digestion and Absorption in Normal Individuals and in Patients with Diseases of Fat Absorption 791
SHINGLETON, WILLIAM W., ET AL. Evaluation of Pancreatic Function by Use of I^{131} Labeled Fat 791
TAYLOR, G. W., ET AL. Lymphatic Circulation Studied with Radioactive Plasma Protein ... 791
SHAPIRO, IRVING. Radioactive Phosphorus in Differential Diagnosis of Ocular Tumors 792
DIAMOND, HENRY D., ET AL. Radioactive Phosphorus. III. In Treatment of Malignant Lymphomas, Plasma-Cell Myeloma, Ewing's Sarcoma, and Osteogenic Sarcoma 792
EASSON, E. C. A Quantitative Study of the Radiosensitivity of Chronic Leukaemia 792
LEVINE, BENNETT, ET AL. Distribution and Effect of Colloidal Chromic Phosphate (P^{32}) Injected into the Hepatic Artery and Portal Vein of Dogs and Man 793
REID, ALLEN F., ET AL. Oxalate Inhibition of Phosphate Loss from Erythrocytes of Carcinoma Patients 793
HAYBITTLE, J. L. Dosage Distributions from "Hairpins" of Radioactive Tantalum Wire .. 793
ANDERSON, W. A. D., ET AL. A Study of Toxic Doses of Strontium-90 (Sr^{90}) in the Adult Rat 793
ANDERSON, W. A. D., ET AL. Cancerogenic Effects of Ca^{45} and Sr^{89} on Bones of CF_1 Mice 794
MACDONALD, N. S., ET AL. Discrimination of Calcium and Strontium by the Kidney 794
CHRISTOPHERSON, WILLIAM M., ET AL. Studies of Interstitial Radiolutetium (Lu^{177}) in the Dog 794
LEEVY, CARROLL M., AND GREENBERG, JOSEPH. Radioisotope Scanning as a Guide to Needle Biopsy of the Liver 794
MICHEL, W. S., ET AL. Designing Sensitive Plastic-Well Counters for Beta Rays 795
HINE, G. J., AND MILLER, A. Large Plastic Well Makes Efficient Gamma Counter 795
HARRIS, C. C., ET AL. A CsI(Tl)-Crystal Surgical Scintillation Probe 795
RIEGERT, A. L., ET AL. Ag-Phosphate Glass Needles for Measuring Gamma Dose 795

RADIATION EFFECTS—PROTECTION

POPPEL, M. H., ET AL. Permissible Dose Problems with Special Reference to Diagnostic Procedures 796
CRUZ, MIGUEL, ET AL. Postradiation Bone Sarcoma. Eleven Cases 796
KOLÁR, JAROMÍR, AND VRABEC, RADKO. Bone Injuries Associated with Roentgen Ulcers ... 796
KURTH, M. E., AND BENEDEK, TIBOR. Extensive Sacral Radiation Carcinoma Superimposed on "Bathing Trunk" Nevus 797
SIMPSON, C. LENORE, AND HEMPELMANN, L. H. Association of Tumors and Roentgen-Ray Treatment of the Thorax in Infancy 797
WHITFIELD, A. G. W., AND KUNKLER, P. B. Radiation Reactions in the Heart 797
DA SILVA HORTA, JORGE. Late Lesions in Man Caused by Colloidal Thorium Dioxide (Thorotrast). A New Case of Sarcoma of the Liver Twenty-Two Years After the Injection 797
RUNDO, J. Determination of the Distribution of Internally Deposited Thorium by Studies within a Realistic Phantom 798
MOLE, R. H. Quantitative Observations on Recovery from Whole Body Irradiation in Mice 798
NOWELL, PETER C., ET AL. Distribution and in Situ Growth Pattern of Injected Rat Marrow in X-Irradiated Mice 798
NEWISSEN, D. J. Effect of Mercaptoethylamine on Survival of Mice Irradiated with Cobalt 60 799
CASTER, W. O., ET AL. Changes in the Cardiovascular System Following Total Body X-Irradiation 799
FRENCH, ARTHUR B., AND WALL, PATRICIA E. Effect of Whole Body X-Irradiation on Plasma and Intestinal Cholinesterase and on Drug Responses of Isolated Intestinal Loops in the Rhesus Monkey, Rat, and Guinea Pig 799
EBERSOLE, JOHN H. Radiation Exposure Patterns Aboard the USS Nautilus 800
HOFFMAN, JOSEPH G., AND HEMPELMANN, LOUIS H. Estimation of Whole-Body Radiation Doses in Accidental Fission Bursts 800
CLEMEDSON, CARL-JOHAN, AND NELSON, ARNE. Effects of a High Explosive Blast in Mice with Radiation Injury 800

ROENTGEN DIAGNOSIS

THE HEAD AND NECK

The Radiographic Localization of Intracerebral Gliomata. J. W. D. Bull and R. L. Rovit. J. Fac. Radiologists **8:** 147–157, January 1957. (National Hospital, Queen Sq., London, England)

About half of all brain tumors are gliomas. Their precise localization is difficult, since they often infiltrate along tissue planes, producing no gross disturbances of structure or function. In an effort to assess the accuracy of presently used diagnostic methods, 100 cases have been reviewed and the neuroradiological findings analyzed.

There were 61 males and 39 females in the series. Ninety per cent of the cases occurred in the fourth to seventh decades of life. Forty-three tumors were right-sided; 25 were bilateral. The site of origin was indefinite. In 53 cases the temporal lobe was involved. In 64 per cent the tumor extended deeply and centrally, and so was inoperable.

Plain skull films revealed signs of increased intracranial pressure in 42 per cent of patients. In the cases with pineal calcification, 3 out of 4 showed a shift toward the side opposite from the tumor. In 3 cases the tumor itself contained visible calcification. Air studies and arteriographic studies were about equally effective for localization. However, in less than half the cases so studied was definition of the tumor very accurate.

In about one-third of the cases the radiographic findings were not diagnostic; in one-third they were suspicious, and in the final one-third they were called pathognomonic for glioma. The pathognomonic criteria were: characteristic tumor vessels and staining; ragged ventricular outline in area adjacent to tumor; outline of a mass in a frontal lobe; cysts, either solitary or multiple, outlined by air. A normally situated pineal does not always rule out a large neoplasm, and subsequent plain films may show a shift as the glioma enlarges.

The presence of bilateral involvement in 25 per cent indicates that, in a patient with a demonstrable glioma, contrast studies should be performed on both sides. If, with negative radiologic findings, a patient continues to show an increasing neurological deficit, repeat air contrast and angiographic studies are indicated.

Nineteen figures, including 2 roentgenograms; 3 tables.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

Extracranial Subperiosteal Epidermoid Cyst in the Frontal Bone. A. Ravelli and L. Winkler. Radiol. clin. **26:** 13–20, January 1957. (In German) (Zentralröntgeninstitut der Universität, Innsbruck, Austria)

The authors use a case of subperiosteal epidermoid cyst in the frontal bone of a 7-year-old child as a text for a general discussion of this congenital lesion and its roentgen differentiation in respect to subperiosteal, diploic, or extraperiosteal origin.

Both epidermoids and dermoids are congenital cystic structures, the latter containing ectodermal and mesodermal structures, but the former only ectodermal tissue. Because it frequently contains cholesterol, the epidermoid previously has been called cholesteatoma. In the skull, the dermoids are usually intracranial; the epidermoids are also predominantly intracranial but may be found in the diploe and extracranially. The intracranial presence of rim of calcium does not allow a definite differentiation between these two cysts. If a tooth is visualized, differentiation is possible.

The authors propose a classification of the epidermoids according to location: (1) extracranial (subcutaneous, epiperiosteal, and subperiosteal), (2) intradiploic, (3) intracranial (epidural, subdural), (4) combination of intra- and extracranial. The favorite sites of the subperiosteal epidermoids are in the frontal, temporal, and occipital bones and the facial skeleton. The favored sites of the subdural epidermoids (either extra- or intracerebral) are the brain stem, cerebellopontine angle, chiasm, sylvian fissure, the ventricles and the hemispheres.

Radiologic findings give information as to the site of the cyst, *i.e.*, epiperiosteal, subperiosteal, or intradiploic. The first form produces erosion of the outer table with no spur formation at the border of the erosion. Spur formation is marked in the subperiosteal variety, and is usually less in the intradiploic. The authors ascribe the formation of spurs to the tension of the periosteum exerted at the edges of the bone defect incident to the slow growth of the cyst. No calcification is seen under the periosteum except at its edges, because the activity of the osteoblasts in the cambium layer of the pericranium is suspended as a result of the direct pressure of the cyst. The forces exerted upon the periosteum at the edges of the lesion are in the form of tension rather than pressure. Here, the activity of the osteoblasts of the cambium layer remains intact, with the production of spurs. This process of spur formation is identical to that seen in a variety of subperiosteal lesions of the long bones that elevate the periosteum. It is not a pathologic function, but solely physiologic.

Two roentgenograms; 1 drawing.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

An Experimental Study of Sialography, and Its Correlation with Histological Appearances, in Normal Parotid and Submandibular Glands. I. Ranger. Brit. J. Surg. **44:** 415–418, January 1957. (Bland-Sutton Institute of Pathology, Middlesex Hospital, London, England)

Sialography was done on 40 normal excised parotid and submandibular glands from postmortem material, with graded amounts of neo-hydriol. The roentgen findings were correlated with the histologic observations, in order to study the mechanism of normal filling and the globular appearance of "sialectosis" described in chronic parotitis.

The diffuse opacity of the parenchyma on sialography is due to irregular distention of the acini. In addition, 13 out of 20 normal parotids showed occasional small globules; these were caused by extravasation of the medium through ruptured intralobular ducts. The duct rupture was not seen in 20 normal submandibular glands, possibly because their ducts are shorter and wider, with less hold-up of medium.

When rupture occurred in the parotid ducts it was demonstrated before the phase of acinar filling; the globules were similar to those seen in chronic parotitis, but scattered and few in number. Thus the diffuse

globular appearance in chronic parotitis is probably due to some factor which makes the intralobular duct more liable to rupture.

A complete pattern was obtained in all cases with 0.5 c.c. of the contrast substance. Any increase in quantity tended to obscure this pattern because of excessive acinar filling and, in the case of the parotid glands, increased ductal rupture.

Eight roentgenograms; 3 photomicrographs.

LAWRENCE A. POST, M.D.
University of California, S.F.

THE BREAST

Roentgen Screening of Mammary Tumor Progression. J. Gershon-Cohen and Helen Ingleby. Am. J. Roentgenol. **77:** 131–137, January 1957. (J. G.-C., Albert Einstein Medical Center, Northern Division, Philadelphia 41, Penna.)

The authors regard periodic roentgen examination of the breast in women over thirty-five years of age as an eminently satisfactory method for demonstrating possible tumor progression. Particularly is this true following removal or biopsy of benign lesions.

The question is raised, however, whether the radiologist could attain sufficient accuracy in interpretation of breast survey films that this method would be as reliable as possible serial biopsies in following and evaluating progression of breast tumors [presumably benign] and in recognizing the earliest malignant changes so that effective surgical attack could be undertaken. Most malignant lesions present roentgen signs thought by the writers to be pathognomonic. These include spiculated, invasive borders, punctate calcifications, visible in 30 per cent of all breast cancers, and other subtle signs of duct change and soft-tissue configuration. It is admitted that experience in the interpretation of films of the breast must be obtained and that persons attempting their evaluation must be willing to undergo a period of clinical, pathological, and radiological correlative study to gain proficiency and confidence. The authors feel that the radiological method is basically sound and reliable.

A clinic for periodic roentgenographic survey of the breasts of healthy women over thirty-five years of age has been inaugurated at the Albert Einstein Medical Center Hospital.

Three roentgenograms; 3 photomicrographs.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

THE CHEST

Lung Changes in Systemic Lupus Erythematosus. E. Sövényi and Gg. Bencze. Fortschr. a. d. Geb. d. Röntgenstrahlen **86:** 17–24, January 1957. (In German) (I. Medizinalwissenschaftliche Klinik der Universität Szeged, Szeged, Hungary)

The authors report on the pulmonary changes in 4 patients with systemic lupus erythematosus. All 4 had an exudative pleurisy, and in 3 this was bilateral. The first patient had a necrotizing bronchial pneumonia terminally. The second patient presented a high diaphragm both before and after the appearance of intrapulmonary changes. With the development of the lung changes, the hili became enlarged and ill-defined. A migrating bronchial pneumonia was visualized in the lower portions of the lung, but later resolved. This was accompanied by a persisting spotty-stringy change which existed for eleven months in the absence of symptoms. The left upper lobe contained a tuberculous infiltration with cavity formation which responded to therapy. In this connection it is pointed out that the possibility of tuberculosis should be considered in lupus, especially in those patients treated with adrenal cortical hormone.

The third patient demonstrated, terminally, pulmonary edema and bronchial pneumonia similar to the "antigenic pneumonitis" of Sante. In the fourth case there was a small bilateral pleural effusion, with multiple atelectatic streaks in both lower lung fields. The contour of the diaphragm was ill-defined.

As is apparent from this small series, the roentgenologic and pathologic findings in the lungs in lupus are indeed varied and by no means characteristic. The collagen diseases, tuberculosis, sarcoidosis, bronchial pneumonia, tumors, and infarcts may show similar roentgen changes.

Seven roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Roentgen Diagnosis of Pulmonary Mycoma. Herman Lodin. Acta radiol. **47:** 23–28, January 1957. (University Hospital, Uppsala, Sweden)

Four examples of pulmonary mycoma (intracavitary fungus ball) are illustrated and discussed in this article. In 3 cases the radiologic appearance was typical, a mobile, rounded, tumor-like opacity, situated in a cavity and surrounded by a layer of air. In the fourth case there was a lobulated homogeneous density without a layer of air. Tomography is advised for the best demonstration of the characteristic features.

Mycoma is most frequently the result of *Aspergillus* infection, but cases due to *Monilia candida* and *Streptomyces* have also been seen. Two views concerning pathogenesis have been advanced. Some feel that the infection is primary. Others believe the fungus to be a saprophytic complication of other healed or partially healed lesions, such as bronchiectasis or abscess. To be differentiated are tuberculoma and an abscess with a slough.

Twelve roentgenograms.

RICHARD G. LESTER, M.D.
University of Minnesota

THE HEART AND BLOOD VESSELS

Controlled Puncture and Contrast Injection into the Left Ventricle of the Heart. Björn Nordenström, Melvin Figley, and Herbert Sloan. Acta radiol. **47:** 33–45, January 1957. (M. F., University Hospital, Ann Arbor, Mich.)

Selective injection of contrast material directly into the left ventricle for rapid film investigation of cardiac diseases could be of considerable value. Lesions of the mitral and aortic valves and defects in the ventricular septum might well be evaluated by such a method. Successful injections have been reported by a number of workers [see, for example, the paper by Lehman *et al.* Am. J. Roentgenol. (**77:** 207–234, February 1957), which had not appeared at the time of the present report.—R. G. L.] Occasionally, however, there have been complications, as pneumothorax, pneumopericardium, hemopericardium, liver hemorrhage, myocardial hemorrhage, and disturbances in cardiac

rhythm. Blind injection may result in the contrast material being deposited in the cardiac muscle or in the pericardium.

The authors describe a method of avoiding these poorly placed injections, which has been used in 25 experiments on 16 dogs. A lead centimeter scale was placed below the xiphoid process of the animal, preliminary anteroposterior and lateral films were made, and a point was chosen ideally representing the middle of the left ventricular cavity. Measurements were then made on the preliminary films and the direction and depth of the needle plotted by triangulation. Externally placed protractors were used to guide the needle, which was specially designed for this purpose, with an obturated tip and multiple small holes near the tip to direct the medium into eight jets.

No serious complications were encountered in this experimental series. During the procedure there were occasional extrasystoles, and T-wave inversion in Leads II and III was regularly observed at the conclusion of the procedure.

Fourteen figures, including 5 roentgenograms.

RICHARD G. LESTER, M.D.
University of Minnesota

Patent Ductus Arteriosus in Infancy. S. Richard Bauersfeld, Paul C. Adkins, and Edward M. Kent. J. Thoracic Surg. **33**: 123–132, January 1957. (S. R. B., School of Medicine, University of Pittsburgh, Pittsburgh, Penna.)

Over a three-year period the authors saw 74 children with patent ductus arteriosus confirmed by surgery or autopsy. The series includes 55 females and 19 males. Twenty-two, or 30 per cent, of the patients were under the age of two years. In the majority there was a history of dyspnea, frequent respiratory infections, and poor weight gain. In 9 of the 22 cases in infants the diagnosis was made when the child was first seen, on the basis of a continuous murmur in the pulmonic area with substantiating evidence on physical examination and fluoroscopy of the heart and lungs. Increased left ventricular prominence and increased pulmonary blood flow were significant findings.

The main condition requiring differential diagnosis was high ventricular septal defect. For this purpose retrograde aortography was carried out. The modified technic of Keith (Circulation **2**: 907, 1950. Abst. in Radiology **57**: 602, 1951) was used, and the method is described.

Two patients died before surgery was accomplished, 2 expired three months postoperatively, and the remaining 18, followed for periods of one to twenty-seven months, had done well, indicating the advisability of aortography to establish the diagnosis and permit surgical intervention.

The article is followed by an excellent discussion by Drs. Dammann, Hurt, Fall, Sones, Warden, and Stephens.

Two roentgenograms; 4 tables.

GORDON L. BARTEK, M.D.
Grand Rapids, Mich.

Ebstein's Disease: Description of the Heart of the First Case Diagnosed During Life. Louis A. Soloff, Herbert M. Stauffer, and Jacob Zatuchni. Am. J. M. Sc. **233**: 23–27, January 1957. (Temple University School of Medicine and Hospital, Philadelphia, Penna.)

The authors in 1951 reported the first case of Ebstein's anomaly diagnosed during life (Am. J. M. Sc. **222**: 554, 1951. Abst. in Radiology **59**: 601, 1952). The patient has since died during a cardiac operation and a description of the heart is presented.

The hemodynamics of the anomaly are discussed and it is shown that the angiocardiographic findings are a logical consequence of the cardiac abnormalities and the altered circulatory dynamics. The pathognomonic angiocardiographic feature is the nonopacified narrow band separating the very greatly enlarged right atrial chamber from the diminutive right ventricle. This narrow nonopacified band is identified as the muscular ridge at the caudal line of fusion of the three leaflets of the anomalous tricuspid valve. Immediately proximal to this ridge is the auriculized right ventricle that is continuous with the right atrium, with which it is homogeneously opacified.

Two roentgenograms; 2 photographs; 2 drawings.

H. C. JONES, M.D.
Grand Rapids, Mich.

Myxoma Cordis. Diagnosis Established Pre-operatively; Surgical Removal of the Tumour. F. S. P. Van Buchem and L. D. Eerland. Dis. of Chest **31**: 61–73, January 1957. (State University of Groningen, Groningen, Netherlands)

The authors report the case of a 45-year-old male in whom they made a preoperative diagnosis of pedicled tumor of the left atrium, myxoma cordis. This is a rare condition, accounting for about 50 per cent of the primary tumors of the heart. The tumors are usually polypoid, with a pedicle, are partly gelatinous and partly of a rubber-like consistency. They arise from the auricular septum close to the foramen ovale, and in 75 per cent of the cases are situated in the left atrium. They have been observed in all age groups in both sexes, and vary in size from that of a pea to a closed fist. The smaller tumors cause no symptoms.

The authors' patient suffered from palpitation and a sense of oppression in the chest on exertion, which disappeared with rest. These complaints gradually progressed, were associated with changing position, and were soon followed by severe dyspnea, even on the slightest exertion.

X-ray examination of the chest showed no enlargement of the heart. The main pulmonary vessels were distended, and the vascular markings were accentuated. An esophagogram showed evidences of an enlarged left atrium. Fluoroscopic examination revealed strong pulsatory movements of the esophagus at the level of the left atrium. The electrocardiographic and cardiac catheterization findings were compatible with mitral stenosis without murmurs, with pulmonary congestion. The diagnosis of an interatrial tumor was made by angiocardiography, which demonstrated a space-occupying lesion, appearing as a defect in the contrast substance in the left atrium.

While in the hospital, the patient suffered a severe attack of decompensation. Following this, he recovered somewhat and surgery was decided upon even though the prognosis was not considered favorable. During preparation for surgery under hypothermia, cardiac arrest developed, which necessitated thoracotomy and cardiac massage. Cardiac rhythm was restored, surgery was continued, and a short pedicled polypoid tumor was detached from the septum. Death ensued from repeated ventricular fibrillation.

There were found in the literature 6 cases of myxoma

cordis diagnosed preoperatively, with a single survival (Crafoord, cited by Goldberg and Steinberg: Circulation **11**: 963, 1955).

Eleven figures, including 4 roentgenograms.

HENRY K. TAYLOR, M.D.
New York, N. Y.

The Clinical Problem of Adiposity of the Heart and Cardiac Enlargement of Undetermined Etiology. H. J. Roberts. Dis. of Chest **31**: 84–92, January 1957. (6618 S. Dixie Highway, West Palm Beach, Fla.)

The author reports the case of a 30-year-old active male who gained 51 pounds (179 to 230) in weight during a two-year period in the Navy. The heart was of normal size on a routine induction film, but two years later was found to be enlarged, with no apparent cause. Active duty was continued without difficulty, but on the patient's discharge from the navy, the heart size was reported as "20 per cent above that predicted for his height and weight." There were no actual stigmata of rheumatic fever, hypertension, coronary disease, or congenital defects.

Three years after the patient's discharge from the navy, numerous chest x-ray examinations revealed an apparent left ventricular enlargement with slight prominence of the left pulmonary artery segment. Fluoroscopy showed bilateral enlargement, involving particularly the left ventricle. The auricles were not enlarged, the esophagus was not displaced, and there was no intracardiac calcification. Roentgenographic examination of the skull, urinary tract, and upper portion of the gastrointestinal canal showed no abnormal findings. Electrocardiograms revealed right bundle-branch block.

The author considered the cardiomegaly as possibly related to "adiposity of the heart" because of the profound weight gain and the absence of etiological factors for cardiac disease. The patient was accordingly placed on a vigorous weight reduction program. After two months he had lost 20 pounds, and the transverse diameter of the heart had decreased 1.5 cm. After six months the loss of weight was 45 pounds, with no further decrease in the size of heart. The right bundle-branch block persisted.

The author discusses the problem of "cardiac enlargement of undetermined origin"; and considers the common causes for cardiac enlargement. To the above he adds endomyocardial fibroelastosis, idiopathic cardiac hypertrophy, chronic myocarditis, the "athletic heart," Friedreich's disease, familial cardiomegaly, prolonged bradycardia, prolonged tachycardia, and pulmonary embolism with cor pulmonale, von Gierke's disease, "congenital dilatation of the heart" in adults, and the so-called parchment heart.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Diagnosis of Congenital Aneurysm of the Ventricular Septum During Life. Israel Steinberg. Brit. Heart J. **19**: 8–12, January 1957. (New York Hospital, Cornell Medical Center, New York, N. Y.)

A single case of localized aneurysm of the ventricular septum is presented. The patient was a sixty-year-old woman with an otherwise apparently normal heart. An angiocardiogram was obtained because of suspicion of some type of shunt, but none was found. On the frontal view a bulge into the right ventricle was seen when the left ventricle became opacified. A corresponding filling defect in the right ventricle was not demonstrated, because the oblique position was not used. The case is unproved, but the author believes the diagnosis is supported by the angiocardiographic observations. A case found at autopsy in a boy of eight years is cited for comparison.

Three roentgenograms; 1 photograph.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Congenital Heart Disease and Scoliosis. Walter D. Wright and John J. Niebauer. J. Bone & Joint Surg. **38-A**: 1131–1136, October 1956. (Division of Orthopaedic Surgery, Stanford University School of Medicine, San Francisco 15, Calif.)

It has been a clinical impression that scoliosis is more prevalent among patients with congenital heart disease than in the general population. An investigation has been carried out by the authors to determine the validity of this impression and, if possible, to shed some light on the factors which influence the development of spinal curvatures in patients with congenital heart lesions.

The roentgenograms of 425 patients (212 males, 213 females) with known congenital heart disease from the cardiovascular files of Stanford University Hospitals (San Francisco, Calif.) were studied. Three cases of congenital bony abnormality were excluded because bone abnormalities may themselves initiate a spinal curvature. The scoliosis was measured according to the method described by Cobb and others. No lateral deviation of less than 10° was considered, since the position of the patient, differences in limb length, pelvic tilt, and inaccuracies in measurements often produce minimal functional curvatures. As a control, 200 roentgenograms reported negative for pulmonary or cardiac disease were reviewed. These films were of individuals fourteen to thirty-five years of age. The cases were studied with attention to the following factors: (1) incidence of scoliosis in patients with heart disease, (2) incidence of scoliosis in the control group, (3) changes in curvature following surgery, (4) relation of cardiac enlargement to scoliosis, (5) type of curvature, (6) degree of curvature, (7) type of heart disease, and (8) apex of deviation.

In the 422 cases of congenital heart disease, there was an incidence of 5.5 per cent (23 cases) of scoliosis of 10° or over. If only the 72 individuals fourteen years old and over were considered, however, the incidence of spinal deviation of 10° or over was 19 per cent (14 cases). In the control group 12 out of 200 (6 per cent) had a spinal curvature of 10° or greater. There was a predominance of right thoracic curvatures, but there was no definite pattern which could be attributed to any one kind of heart disease.

One roentgenogram; 4 tables.

Idiopathic Pulmonary Hypertension. Donald Heath, William Whitaker, and James W. Brown. Brit. Heart J. **19**: 83–92, January 1957. (W. W., The City General Hospital, Sheffield, England)

Four cases of idiopathic pulmonary hypertension are presented, 3 with autopsies. Clinically they were quite similar, with dyspnea, cyanosis, and the usual ankle edema and ascites associated with right heart failure. None of the patients had chest pain, although this is a common complaint in this condition. All had a history of chronic cough and respiratory infections. Three

patients were females, of twelve, twenty-one, and forty-five years. The single male was thirteen years of age.

Cardiac catheterization confirmed the hypertension in the right ventricle and ruled out any left-to-right shunts or other causes of secondary pulmonary hypertension. Electrocardiograms demonstrated right ventricular dominance.

Plain films and fluoroscopy showed cardiac enlargement and increased size and pulsation of the pulmonary arteries and their primary branches. Angiocardiography was performed in 2 cases, confirming the findings on plain films and ruling out other lesions.

Histologically the pulmonary arteries showed intimal thickening and fibrosis, with frequent occlusion and the presence of a distinct muscular media in the arterioles, which normally consists of a single elastic lamina. Medial necrosis was also observed in the muscular arteries and arterioles.

No treatment is of any avail in this condition. The course is progressively downward, ending in death from congestive failure, usually within two years.

Four roentgenograms; 4 photomicrographs; 2 electrocardiograms.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Solitary Pulmonary Hypertension. William Evans, D. S. Short, and D. Evan Bedford. Brit. Heart J. **19:** 93–116, January 1957. (London Hospital, London, England)

Eleven cases of solitary pulmonary hypertension studied both clinically and at autopsy form the basis of this report. All patients were female, ranging in age from seven to sixty-four years at death. Dyspnea, anginal pain, syncope, and exhaustion were the principal symptoms.

On plain films, right ventricular enlargement was seen in all but 1 case and right atrial enlargement in all but 2; the pulmonary artery was dilated in every instance. The electrocardiogram showed ventricular predominance in all, and the presence of hypertension in the right heart was confirmed in all in whom catheterization was done.

The clinical course was relentlessly progressive after the onset of symptoms, averaging only two and a half years. The diagnosis is made by excluding the various known causes of secondary pulmonary hypertension, such as chronic lung disease, mitral stenosis, and congenital cardiac lesions.

Significant histologic findings consisted mainly of intimal proliferation and thrombosis of the muscular arteries and the arterioles.

Twenty-four figures, including 4 roentgenograms and 6 arteriograms.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Thoracic Aortography. John B. Johnson, John W. Lawlah, Frederick McFadden, and Joseph F. Dyer, Jr., with the technical assistance of Audrey I. Fairley and Vera Collings. Am. Heart J. **53:** 40–51, January 1957. (Freedmen's Hospital, Washington 25, D. C.)

In the authors' hands, retrograde aortography by means of femoral artery catheterization has afforded visualization of all portions of the thoracic and abdominal aorta, and the brachiocephalic vessels. They have made 86 injections in 18 patients with no untoward results. By this means it was found possible to distinguish between vascular and nonvascular superior mediastinal masses. Thus, a mass in the right infraclavicular area was shown to be an aneurysm of the innominate artery, while in another case an aneurysm was excluded and operation revealed a large retrosternal thyroid. In a third case, a mass thought to be an aneurysm of the thoracic aorta proved to be a slightly dilated descending thoracic aorta and a right aortic arch. The authors also demonstrated the root of the aorta and the aortic valves and accomplished left ventricular filling in a case of cardiac decompensation. The abdominal and iliac arteries can be visualized to determine intrinsic pathology and sites of narrowing or constriction.

An 11- or 12-gauge thin-walled trocar needle is inserted into the femoral artery in the inguinal region. Polyethylene tubing of appropriate size is threaded through the trocar and, under fluoroscopic control, the tip of the catheter is placed in the desired location, following which 20 c.c. of Renografin (76 per cent) is injected rapidly. General anesthesia is not necessary. Exposures are made at the rate of 2 per second for three to four seconds. Multiple injections were given, two to ten to a patient. The reactions are tabulated. In 1 case there was slight nausea, and in 1 emesis after the second injection; another patient complained of being "hot and dizzy" with slight vertigo for several days when assuming the erect position; 1 complained of pain in the area of the renal arteries; 10 had no reactions, and 4 are described as having no cerebral symptoms.

Fourteen roentgenograms; 1 graph; 1 table.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Aortography with Simultaneous Bilateral Arteriography of the Lower Extremities. Josse Kaye, S. J. Sarif, and M. B. M. Denny. Brit J. Radiol. **30:** 13–18, January 1957. (Johannesburg General Hospital, Johannesburg, Union of South Africa)

The necessity for accurate angiography is stressed by the authors, who state that the newer medical and surgical management of peripheral vascular disease requires precise localization of the pathological process. While unilateral femoral arteriography does reveal lesions and functioning collateral vessels, commonly associated lesions in the pelvic vessels, terminal aorta, and opposite limb remain obscure. Collaterals originating in the pelvic vessels above a superficial femoral block are not demonstrated. The authors have constructed a device which allows serial films of the pelvis and both lower extremities to be taken with one injection of opaque medium into the aorta. These films provide information regarding lesions, collaterals, and blood flow in both extremities simultaneously.

The apparatus consists briefly of a large tray capable of holding two 35 × 8-in. cassettes side by side, which overlaps the Bucky tray in the center of the table by 2 to 3 inches. A trolley containing two more cassettes of similar size can be rolled into position from the side of the table. Suitable lead protection is employed to protect the unexposed films. Two 14 × 7-inch films are placed in tandem in the large cassettes, properly identified by means of markers. A 150 cm. target-Bucky distance is used, and the operators are protected by lead-rubber drapes suspended from the ceiling. Three operators are necessary. The first makes the exposures by working a foot switch adjacent to the x-ray table and also operates the cassette changer. The second changes the time and kilovoltage controls after completion of the pelvic exposure, while the third moves the table from the pelvic area to the lower limb

field. Three exposures are made, the first of the pelvis after the injection of 30 c.c. of 76 per cent Urografin, the second and third of the lower extremities after the completion of the injection (40 to 60 c.c.) A translumbar needle or retrograde catheter is employed for the injection.

The authors plan to overcome the disadvantages incident to the necessity for three radiographic assistants, and the concomitant human error, by constructing a remotely controlled changer operated from the control panel by one person.

Eleven roentgenograms; 3 drawings.

JAMES F. NICHOLS, M.D.
Cleveland City Hospital

The Diagnosis of Traumatic Main-Vessel Thrombosis. G. E. Mavor. Brit. J. Surg. **44:** 337–342, January 1957. (Royal Infirmary, Aberdeen, Scotland)

From the standpoint of prognosis and treatment it is important to try to differentiate traumatic thrombosis of the femoral and popliteal arteries from thrombosis due to atheroma or inflammation. In 164 consecutive cases of peripheral vascular disease in the lower limb the author encountered 5 cases of traumatic thrombosis, 4 involving the popliteal and 1 the femoral artery. Three of the cases were confirmed by histologic examination of the involved segment.

In addition to known direct trauma, it is possible that in rare instances minor strains may play a role. By virtue of anatomic relationships the femoral artery is susceptible to unusual stress at the adductor canal. The distal portion of the popliteal artery often has no anchoring branches and shows longitudinal stretching on hyperextension; 2 of the cases in the author's series gave a history of antecedent hyperextension injury. Although, when the patient is first seen, the entire popliteal is usually occluded, traumatic thrombosis probably begins in the distal segment, with later propagation of the thrombus. In contrast, thrombosis secondary to atheroma usually begins in the proximal portion of the popliteal.

The diagnosis is suggested in patients under forty with a history of direct trauma or hyperextension injury, showing occlusion of the distal femoral or distal popliteal artery on the arteriogram and no atheromatous changes in the vessels of either leg. The author believes that thrombo-angiitis obliterans of the main vessels is rare, and an unlikely cause of exercise calf pain in a young adult. Propagation of a thrombus to occlude the entire popliteal or femoral can occur. The final confirmation depends on resection and histologic examination.

Thirteen roentgenograms; 3 photomicrographs; 1 table.

LAWRENCE A. POST, M.D.
University of California, S.F.

Percutaneous Splenic Portal Venography. R. E. Steiner, Sheila Sherlock, and M. D. Turner. J. Fac. Radiologists **8:** 158–177, January 1957. (Hammersmith Hospital, London, England)

This paper is based upon 100 percutaneous transsplenic venograms. Injections were made with a long needle directly into the substance of the spleen usually through the eighth or ninth intercostal space in the midaxillary line. For adults 40 c.c. of 70 per cent Diodone was given (10—20 c.c. for children) and films were made rapidly thereafter up to about 10 or 12 seconds. The objectives were: assessment of patients with portal hypertension and gastrointestinal hemorrhage; investigation of portocaval shunts; diagnosis of extrahepatic portal vein obstruction; study of unexplained splenomegaly; elucidation of obscure chronic neuropsychiatic disorders in the presence of portal cirrhosis; diagnosis of neoplasms involving the splenic or portal veins.

The procedure is contraindicated in deeply jaundiced patients; in those with delayed prothrombin time; in the presence of ascites; in Diodone sensitivity; and in many patients who have impalpable spleens. The only serious complication is intraperitoneal hemorrhage. This was observed twice in the authors' 100 cases of the series, and each required transfusions. Extrasplenic injection of Diodone was temporarily painful, but otherwise produced no ill effects in the 6 patients in whom it occurred.

In the normal subject the venogram showed a pool of Diodone in the spleen, most of which disappeared in a few seconds. The main splenic vein was outlined, and the medium then flowed rapidly along the portal vein, filling its branches and smaller radicles out to the periphery of the liver. Normally no filling of portal collateral vessels or reflux into portal tributaries was seen. Later, medium in the sinusoids produced a hepatogram. The normal splenic and portal veins were shown to vary considerably in size.

In the presence of portal obstruction, whether intrahepatic (cirrhosis) or extrahepatic, the most striking feature was filling of collateral vessels. The pattern varied widely from case to case.

In the presence of chronic neuropsychiatric disturbances and suspected portal cirrhosis, the failure to show collaterals was felt to indicate that the mental difficulty was unrelated to liver disease.

The venograms were especially useful in differentiating extrahepatic portal obstruction from intrahepatic obstruction. The method was also found to show esophageal collateral circulation more often than the barium-swallow examination. The splenic venograms were also very useful in appraising the condition of portocaval shunts after surgery.

Twenty-one roentgenograms; 2 photographs; 21 diagrams; 5 tables.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

Portal Circulation in Portal Hypertension. I. Bergstrand and C.-A.Ekman. Acta radiol. **47:** 1–22, January 1957. (University Hospital, Lund, Sweden)

Lienoportal venography has proved useful in the evaluation of circulatory disturbances associated with portal obstruction. The authors have studied different aspects of these disturbances as judged by changes in the collateral circulation, the velocity of flow, and the width of the portal and splenic veins. Their technic was essentially the same as that previously described (Acta radiol. **43:** 377, 1955. Abst. in Radiology **66:** 460, 1956). Triurol 50 per cent (sodium acetrizoate) was the usual medium and injections were made through a cannula containing a mandrin. A total of 136 examinations were carried out, of which 115 were considered successful. From this series a group of 54 patients with verified portal hypertension and 16 control patients were selected for study.

Collateral vessels were found to fill regularly in patients with portal hypertension, but never in its absence. The most regularly filled collateral in the presence of intrahepatic or posthepatic obstruction was the

coronary vein. The short gastric veins and inferior mesenteric vein were filled less frequently. In prehepatic obstruction, filling of the collateral vessels was dependent upon the position of the obstruction. No relation between the degree of portal hypertension and the extent of visualization of collaterals was found, however. Correlation between the extent of collateralization and the extent of esophageal varices was also not as sharp as might be expected, although there was good correlation of the presence of these two phenomena.

In patients with cirrhosis, the liver parenchyma was less densely opacified than in the controls, and the hepatic veins were less often demonstrated.

With portal hypertension, the splenic and portal veins were often, but not invariably, dilated. Increase in width of the veins appeared to be less in the presence of ascites.

Velocity of the portal circulation was measured in terms of the spleen-hilus time (interval between beginning of injection to demonstration of bifurcation of the portal trunk in the liver hilus), spleen-liver time (contrast material filling the intrahepatic portal branches), and emptying time of the portal branches (contrast material evenly opacifying the liver parenchyma). An automatic film changer was used to make films at the rate of one per second for thirteen seconds, and one film every three seconds for the following 20 seconds. With this method the hepatic veins were often seen. Utilizing each of the time measurements indicated, the velocity of flow in the portal circulation was practically always found to be slower in cases of portal hypertension than in the control patients.

Thirteen roentgenograms; 4 diagrams; 1 table.

RICHARD G. LESTER, M.D.
University of Minnesota

THE DIGESTIVE SYSTEM

Pseudodiverticular Dyskinesia of the Esophagus. Giovanni Piazza. Radiol. clin. **26:** 26–38, January 1957. (In Italian) (Istituto di Radiologia-Clinica Medica, Ospedale Civile, Padua, Italy)

Pseudodiverticulosis of the esophagus has been called by many names, some emphasizing only the spastic component, others the pseudodiverticular. The radiologic picture is characterized essentially by multiple foci of spasm with interposed segments that assume a rounded form recalling the morphology of a diverticulum.

The pseudodiverticula are round or elliptic and tend to occur in the lower and middle third, but can also be found in the upper third; they may be central or more or less eccentric in respect to the esophageal lumen. In number they range from 1 to 5, rarely more. Most often they are arranged one above the other, but at times are separated by some distance. The picture is transient, though with definite and constant morphology. Only rarely, however, does the esophagus become completely regular during physiological dilatation. More commonly, slight undulation persists in the dyskinetic segments, the irregularities corresponding to the pseudodiverticula. The pseudodiverticula are best seen posteriorly, because this direction offers the least resistance to their growth.

Functionally, esophageal pseudodiverticula have three phases: the first of active dilatation, the second of passive dilatation, and the third of contraction of the wall, in an attempt to evacuate the contents. Its muscle may respond by hypertrophy.

The cause of this condition is not known, though rarely it may be found as a reflex state associated with peptic ulcer, gallbladder disease, and other diseases in the surrounding viscera. In some cases there are no recognizable organic abnormalities, either in the esophagus itself or other viscera.

Radiologically, the picture is characteristic, but it must be differentiated from true diverticula and simple esophageal spasm. Symptoms may be absent or there may be a feeling of momentary obstruction, especially with solid foods, or pain and retrosternal burning.

Antispasmodics are relatively ineffective. Extensive longitudinal myotomy has been done on two patients with encouraging results.

[The scarcity of American references in the bibliography is striking. C. V. C.]

Five figures.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Cardiospasm or Carcinoma? The Roentgen Findings. Richard H. Marshak and Joan Eliasoph. Am. J. Digest. Dis. **2:** 11–25, January 1957. (Mount Sinai Hospital, New York, N. Y.)

Carcinoma of the gastric fundus may extend into the lower esophagus and produce roentgen features which simulate cardiospasm. The correct diagnosis is suggested when one sees a mass in the fundus, an eccentric esophageal lumen, or other alterations in the position and contour of the constricted esophageal segment.

The presence of irregular peristalsis in the esophagus, frequently seen in cardiospasm, is unusual in carcinoma, but this feature is not diagnostic. An increase in the soft tissues between the gastric fundus and diaphragm is suggestive of a neoplasm, but it may also represent incomplete distention of the fundus, interposition of liver or spleen, or infrapulmonary effusion. Flattening of one wall of the lower esophagus due to infiltration is a significant change indicating malignant disease. In carcinoma the narrowed esophageal segment is short, with a rigid lumen; in cardiospasm the constriction tends to be longer, and small changes in distensibility can be seen. With stricture following severe peptic esophagitis the narrowed segment is frequently longer than in cardiospasm, and the rigidity of the lumen varies with the degree of inflammatory involvement. When complete obstruction of the lower esophagus occurs, it is usually due to a carcinoma.

In a patient with long standing cardiospasm any change in symptoms or in the roentgen appearance of the esophagogastric segment should suggest the possibility of a superimposed carcinoma.

Twenty-four roentgenograms.

LAWRENCE A. POST, M.D.
University of California, S.F.

Transient Invaginations of the Gastrointestinal Tract. R. Prévôt. Fortschr. a. d. Geb. d. Röntgenstrahlen **86:** 50–55, January 1957. (In German) (Elbchaussee 165, Hamburg-Othmarschen, Germany).

This is said to be the first report in the literature of transient invaginations in the gastrointestinal canal with roentgenologic studies before and after the invaginations. Four cases are recorded. The first was an ileocecal invagination in a fifty-year-old patient, occasioned by a polypoid fibroma, 40 cm. proximal to the ileocecal valve.

In the second case, in a 61-year-old man, there was marked thickening of the ileocecal valve and a partial invagination. No tumor was demonstrated.

The third case was one of appendiceal invagination in a 53-year-old man. Initially the appendix was not visualized on the barium enema study, but there was a biconcave filling defect in the medial contour of the cecum in the region of the appendix. After evacuation, the cecum was better filled and the appendix was well visualized.

The fourth case was one of transpyloric prolapse of the gastric mucosa. The author properly expresses the opinion that in most of the cases such a finding is without significance.

Eight roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Gastric Ulcer in the Older Age Group. Michael M. Klein and Robert L. Bradley. Am. J. Roentgenol. **77:** 25–37, January 1957. (R. L. B., VA Hospital, 1540 Spring Valley Drive, Huntington 1, W. Va.)

The authors studied 32 cases of gastric ulcer, all but 2 of which were proved by gastroscopy or surgery. Only 4 of the patients were less than forty-five years of age; the average was 55.3 years. Six ulcers were found in the antral portion (distal third), all in persons under the age of fifty. The average age of those with ulcers in the proximal two-thirds was 60.3 years. Only 1 case (in a man of sixty-four) proved to be malignant, indicating that gastric ulcers in the older age group tend to be benign.

Symptoms are not characteristic. The one most often observed in the series reported here was indigestion of long standing (81 per cent). Healing is usually rapid, with little residual deformity, but recurrence is frequent.

Gastroscopy is a diagnostic adjunct but is not infallible. In several of the authors' cases it suggested a malignant lesion but the surgical findings proved benignity.

Seventeen cases are reported, with roentgenograms illustrating features considered significant for differentiation between benign and malignant ulcers, and the fallibility of these is pointed out. "Dogmatic roentgenologic diagnoses as regards malignancy or benignity," the authors conclude, "are unwarranted." Discrepancies between roentgenologic localization and the position of the ulcer as observed at laparotomy may be explained by the curling of the lesser curvature as a result of induration or spasm, or both. The ulcers are often closer to the pylorus than would appear from the roentgenogram.

Twenty-five roentgenograms; 1 drawing; 2 tables.

JOSEPH BEAN, M.D.
Indiana University Medical Center

Hemangioma of the Stomach with a Roentgenologic Diagnostic Point. M. G. Flannery and Milton P. Caster. Am. J. Roentgenol. **77:** 38–39, January 1957. (M. G. F., Ingraham Bldg., Miami, Fla.)

A case is reported of hemangioma of the stomach diagnosed preoperatively. Two gastrointestinal series showed nothing of significance. A third showed a lesser curvature mass containing what appeared to be phleboliths. On the basis of this finding and a history of melena, a diagnosis of hemangioma was made. At exploration, a mass the size of a walnut on the anterior stomach wall in the pyloric region was excised *in toto*. Microscopic analysis revealed an angioma with superficial ulceration and four calculi.

Hemangiomas form a small part of the entire group of infrequent benign tumors of the stomach. Symptomatology varies with the size and location of the lesion. It may mimic acute or chronic gastritis, pylorospasm, carcinoma or, more commonly, a bleeding gastric or duodenal ulcer. Surgical excision has been curative in all cases.

The authors state that this is the twenty-sixth case and the first in which diagnosis was made preoperatively of hemangioma of the stomach, and suggest the presence of phleboliths within a gastric mass as a diagnostic sign.

[A case of hemangioma of the small intestine and mesentery in which the diagnosis was suggested by localized clusters of phleboliths demonstrated roentgenologically has been reported more recently by Madell (Radiology **69:** 564, 1957).—ED.]

One roentgenogram.

R. E. MILLER, M.D.
Indiana University Medical Center

The Effect of Morphine Sulfate on Gastric Motility. Some Radiologic Observations in Man. R. S. Crone and G. M. Ardran. Gastroenterology **32:** 88–95, January 1957. (G. M. A., Nuffield Institute for Medical Research, Woodstock Rd., Oxford, England)

The effects of morphine sulfate on the movements and tone of the stomach were recorded radiologically in 20 healthy male student volunteers. An x-ray image intensifier was used in conjunction with a 35-mm. camera to produce radiographs at the rate of one per second for several periods of seven minutes. Following a control study with barium, each volunteer received an intravenous injection of 4 to 6 mg. of morphine sulfate, the dose depending on the weight and physique of the individual. Five minutes after the injection, the subject was given barium sulfate suspension until the stomach was seen to contain approximately the same amount of barium as in the control examination. A series of films was then taken. Some additional studies were made at thirty minutes and sixty minutes after the injection. Fluoroscopic observations were made at intervals. Particular attention was paid to the rate and depth of peristalsis, the tonic appearance of the stomach, and the filling of the duodenum.

In all the subjects who showed an initial increase in the amplitude of peristalsis after morphine, the depth of the peristaltic waves subsequently diminished, as demonstrated fluoroscopically. This change occurred gradually but by about thirty minutes after the injection, the amplitude of the waves usually was less than in the control period.

In 18 of the 20 subjects, the tone of the stomach appeared to be increased after morphine. In these, the amplitude of peristalsis and the propulsive power of the stomach were also increased for approximately thirty minutes after the injection. This augmented activity was followed by a longer period during which the amplitude of the peristaltic waves was diminished and propulsion virtually abolished. There was no evidence to suggest that morphine produced an increase in tone of the pylorus greater than that of the stomach itself.

Two roentgenograms; 1 table.

JOHN P. FOTOPOULOS, M.D.
Hartford, Conn.

Gallstones Impacted in the Stomach and Duodenal Bulb Demonstrated by Roentgenologic Examination. Edward DeFeo and Stephen C. Meigher. Am. J. Roentgenol. **77:** 40–46, January 1957. (E. DeF., Ellis Hospital, Schenectady 8, N.Y.)

The occurrence of gallstones in the stomach seems to be a rarity. From a review of the literature it appears that only 31 cholecystographic fistulas have been recorded and only 8 examples of gallstones in the stomach, most of these having been reported more than thirty years ago. The authors believe that the two cases which they report are the first in which the gallstones have been demonstrated roentgenographically.

In the first case the gallstone had entered the stomach through a cholecystographic fistula. In the second case no cholecystographic fistula was found and a cholecystoduodenal fistula is assumed to have permitted entry of the calculus into the intestinal tract with subsequent passage into the stomach.

Approximately 50 per cent of the fistulae between the gallbladder and intestinal tract involve the duodenum. Despite this high incidence, there are only a few cases in the literature of stones in the duodenal bulb. Only 6 cases have been proved roentgenologically. The authors report a seventh case, in which the gallstone was demonstrated before and after perforation.

Six roentgenograms; 2 photographs.

THOMAS R. MARSHALL, M.D.
Indiana University Medical Center

Jejunogastric Intussusception as a Rare Complication Following Gastric Surgery. A. Leszler. Radiol. clin. **26:** 21–25, January 1957. (In German) (II. Med. Klinik, Szentkirályi-u. 46, Budapest VIII, Hungary)

The author uses a case of chronic jejunogastric intussusception in a twenty-four-year-old patient two and a half years following gastric resection as a text for a general discussion of this postoperative complication. Over 125 cases had been reported up to 1954.

Roentgenology plays a decisive role in the diagnosis of intussusception of this type. The segment of small intestine is recognized within the stomach by the characteristic Kerkring folds. Either the afferent, the efferent, or both loops may be involved. The combined type is usually an early complication, whereas the others usually occur several years following surgery.

Clinically, the picture is either acute or chronic. In the former, there are cramp-like epigastric pains and vomiting which is characteristically bloody. Symptoms are usually severe. An elastic resistance may be found in the epigastrium. In the chronic variety, the symptoms are intermittent. Spontaneous reduction occurs, and roentgenologic changes will be found only if the patient is examined at the time of an invagination. As in the acute variety, cramp-like pains and vomiting are characteristic, although they are less severe.

Three figures. CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

The Gas-Filled Appendix. Eric Samuel. Brit. J. Radiol. **30:** 27–30, January 1957. (Johannesburg, Union of South Africa)

In a brief but pertinent article the author discusses the appearance of and the possible confusion ensuing from a gas-filled appendix. The appendix is subject to many variations in its anatomical position, but it usually lies at the most dependent portion of the cecum. In its normal location it can remain filled with gas only if its communication with the cecum is occluded and it is the seat of gas-forming organisms. Under these conditions the appendicular gas is usually obscured by the concomitant small bowel ileus. When, however, the appendix remains in its infantile location in the right hypochondrium, it represents, in the erect position, the highest anatomical point in the right colon, and remains gas-filled. Radiologically it appears as a linear area of radiolucency, kinked or bent according to its anatomical position.

In the examination of the acute abdomen, the significance of this shadow may be easily misinterpreted. It must be differentiated from a number of conditions: (1) Gas in the biliary tree, in the presence of an internal biliary fistula, usually shows branching, though small amounts of gas may be confusing. Also, the location of the appendix is likely to be slightly more lateral than the region of the bile ducts. (2) Gas in the gallbladder usually presents a pear-shaped appearance, which is characteristic, though the shadow in a shrivelled gallbladder might be misinterpreted. (3) Gas in an abscess may mimic appendiceal gas in the supine position, but in the erect will usually show a fluid level. This is never seen in a gas-filled appendix.

The author includes 3 case histories which further illustrate his discussion.

Eight roentgenograms. JAMES F. NICHOLS, M.D.
Cleveland City Hospital

New Methods of Demonstration of the Pancreas. N. Macarini and L. Oliva. Fortschr. a. d. Geb. d. Röntgenstrahlen **86:** 55–65, January 1957. (In German) (Istituto Radiologia Università Ospedale S. Martino, Genoa, Italy)

For the authors' method of visualizing the pancreas, the patient stands and tomography is done in the left lateral and transverse axial projections, after gas has been introduced into the stomach and retroperitoneal tissues.

The article is well illustrated with examples of the normal pancreas, pancreatitis, infiltration of the lumboaortic lymph nodes, tumor in the head of the pancreas, and traumatic cyst of the pancreas.

Fifteen roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

The Relationship of Stenosis to Rokitansky-Aschoff Sinuses of the Gallbladder. Gordon J. Culver, David L. Berens, and Berten C. Bean. Am. J. Roentgenol. **77:** 47–54, January 1957. (G. J. C., Buffalo General Hospital, 100 High St., Buffalo 3, N. Y.)

Five case reports, with roentgenograms, are presented to illustrate the relationship of stenosis of the gallbladder to the roentgen visualization of Rokitansky-Aschoff sinuses. The 14 cases previously reported by others are briefly reviewed. All showed a typical cholecystographic appearance with relatively good function plus a thin irregular ring of contrast medium about the lumen of the gallbladder. In all of the authors' cases, and in two-thirds of the collected cases, a definite stenosis or constriction was present in the proximal portion of the gallbladder.

An attempt is made to correlate the roentgen picture with the pathological findings, and it is felt that the area of constriction is an important factor in the development of large Rokitansky-Aschoff sinuses. The constriction is due to hyperplasia of all the gallbladder wall structures.

Three conditions are proposed for roentgen demonstration of diverticula: (1) the gallbladder must be well filled with contrast medium; (2) the diverticula must be sufficiently large and numerous, and closely packed; (3) the sinuses must not contain any appreciable amount of retained bile components. To these, the authors would add the frequent presence of a stenosis or constriction in the proximal portion of the gallbladder.

Eight roentgenograms; 1 photomicrograph; 2 tables.

JOHN L. GWINN, M.D.
Indiana University, Medical Center

Anomalous Termination of the Common Duct. Glenn M. Jones and Harold D. Caylor. Am. J. Surg. **93:** 122–123, January 1957. (Caylor-Nickel Clinic, Bluffton, Ind.)

The authors present a case in which an anomalous termination of the choledochus in the main pancreatic duct was disclosed by operating room cholangiography. There had previously been discovered, during the course of cholecystectomy, an anomaly of the cystic artery, which lay anterior to the cystic duct. Surgeons who encounter anomalies during cholecystectomy would thus be well advised to obtain an operative cholangiogram in an effort to demonstrate other possible anomalies.

One roentgenogram; 1 diagram.

J. E. RHODENBAUGH, M.D.
The Henry Ford Hospital, Detroit

Benign Tumor of the Cystic Duct Producing Symptoms of Chronic Cholecystitis. George A. Olander and Gerald S. Dean. Am. J. Surg. **93:** 124–126, January 1957. (Highland Park Hospital, Highland Park, Ill.)

A case is reported of benign fibroepithelioma of the cystic duct complicated by the presence of an internal hernia. The patient, a 21-year-old white man, gave a long history of abdominal pain. His first operation disclosed an internal hernia. Following repair of this, there was a recurrence of symptoms and, though earlier gallbladder examinations had been repeatedly negative, cholecystography was again undertaken. The gallbladder failed to empty completely in seventy hours and re-exploration was done. The gallbladder was removed and the cystic duct was found to be obstructed by a fibroepithelial papilloma.

Attention is called to the cystic duct as a possible source of biliary symptoms.

Three roentgenograms; 3 photomicrographs.

J. E. RHODENBAUGH, M.D.
The Henry Ford Hospital, Detroit

Cholecystography in the Presence of Jaundice. Edwin M. Cohn, Simon M. Berger, and Victor Kremens. Ann. Int. Med. **46:** 53–59, January 1957. (Albert Einstein Medical Center, Northern Division, Philadelphia, Penna.)

This study was undertaken to determine the feasibility of roentgen examination of the biliary tract in the presence of jaundice, to determine under what circumstances the most desirable results could be obtained, and to investigate the relative merits of the newer oral and parenteral materials employed for opacification of the gallbladder and its ductal system.

Fifty patients, unselected except for the presence of jaundice, were studied. An attempt was made to visualize the biliary tract by the intravenous method, with iodipamide, and as a separate procedure by iopanoic acid administered orally. The diagnosis in each case was established by surgery, by liver biopsy, or by careful clinical evaluation.

The jaundice was classified according to the diagnoses of acute hepatitis, cirrhosis, liver metastases, obstruction, and hemolytic disease. Cases of obstructive jaundice included stone in the common duct, carcinoma of the head of the pancreas, duodenal diverticulum occluding the common duct, metastatic nodes producing extrinsic pressure on the common duct, and edema of the biliary channels associated with attacks of acute cholecystitis.

The gallbladder was visualized in 21 of the intravenous examinations, or 42 per cent. The percentage of positive findings was higher in patients with a serum bilirubin level below 5.0 mg. per cent.

A total of 12 cholecystograms was obtained in patients with obstructive jaundice. Cholelithiasis was observed in 10 cases of this group. In the 7 cases of hepatitis in which the gallbladder concentrated the opaque medium, a normal cholecystogram was obtained. This finding was true also in the cases of jaundice due to hemolytic disease and cirrhosis.

The common duct was outlined in 20 of the 50 cases studied. The duct was not visualized in the presence of a severe degree of jaundice. In the lower levels of bilirubinemia the duct was seen in 15 of 22 cases (68 per cent) of obstructive jaundice, and in 4 of 6 cases of infectious hepatitis.

In 21 cases iodipamide and iopanoic acid were both used in the same patient. The former appeared to be more effective in opacifying the biliary tract in the presence of jaundice.

Roentgen findings were compared with operative findings when both were obtainable in the same patient. In a group of 8 patients whose serum bilirubin was above 5.0 mg. per cent, not one gallbladder was visualized. The surgical diagnoses were cholelithiasis (4), carcinoma of the pancreas (2), and hepatic metastases (2). X-ray and operative findings in 11 cases in the group of less intense icterus were compared. Cholelithiasis was demonstrated roentgenographically in 5 patients and corroborated by surgical exploration. In 6 cases of nonvisualization, stones were found in the gallbladder in each instance at operation.

In view of their findings, the authors conclude that the benefits of x-ray examination of the gallbladder and/or common duct in the presence of jaundice are best derived through positive findings. A normally visualized gallbladder without stones strongly points to intrahepatic disease as the basis of the jaundice, though extrahepatic and extrabiliary obstructive phenomena should not be ruled out as a cause of jaundice by such a normal report.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

Phototimed Erect Compression Spot Films in Cholecystography. C. Rowell Hoffmann. Am. J. Roentgenol. **77:** 55–60, January 1957. (1027 Carew Tower, Cincinnati 2, Ohio)

The author reports his experience using phototimed spot films in cholecystography. Five hundred patients suspected of having gallbladder disease were examined roentgenographically after the ingestion of contrast medium. Phototimed spot exposures with compression, with the patient erect, rapidly provided roentgenograms of uniform diagnostic quality. With this technic, the shadow of the gallbladder could be projected free from those of overlying visceral structures contain-

ing gas in 440 patients. In 40 of the 60 patients where the shadow of the gallbladder could not be projected separately, inflammatory processes with adhesions were found at operation. No gallbladder disease was present in 259 patients. Visualization failed in 46 patients, even after repeat doses of contrast medium. Calculi were present in 103 patients, visible on both prone postero-anterior roentgenograms and those made with the patient erect. In 32 cases calculi were seen on the erect, compression spot films where they had not been visible in postero-anterior projection with the patient prone. This finding demonstrates the value of phototimed spot films made with the patient erect and employing compression.

Eight roentgenograms.

THEODORE E. KEATS, M.D.
University of Missouri

Operative Cholangiography via the Cystic Duct: A Hint on Technic. Stanley O. Hoerr. Am. J. Surg. **93:** 119–120, January 1957. (Cleveland Clinic Foundation, Cleveland, Ohio)

A method for operative cholangiography is described and illustrated by which it is proposed to avoid artefacts due to the introduction of air and reflux of bile or contrast medium. Several turns of ligature are passed around the catheter at approximately 3 cm. and this is secured to the cystic duct after introduction of the catheter. In addition, a ligature is tied proximal to the point of catheter introduction to prevent reflux of bile from the gallbladder. A third ligature distal to the point of introduction, tied with a single knot, prevents both introduction of air and escape of fluid. After completion of the cholangiogram, this third suture is made tight as a square knot to ligate the cystic duct. Cholecystectomy may then be completed.

One figure.

J. E. RHODENBAUGH, M.D.
The Henry Ford Hospital, Detroit

THE DIAPHRAGM

Diaphragmatic Pleurisy or Phrenic Paralysis? Elements of Differential Diagnosis. G. Roche, C. Souvestre and I. Masourenoch. J. franç. méd. et chir. thorac. **11:** 1–12, 1957. (In French) (Hôpital d'Eaubonne, S.-et-O., France)

The diagnosis of phrenic paralysis is often made too quickly and too easily. The majority of cases described as transitory paralysis of the diaphragm are in reality diaphragmatic pleurisies. Some have attributed what was considered as elevation of the diaphragm to contact of the phrenic nerve with serous inflammation. However, in pleurisy associated with pneumothorax, phrenic paralysis is rarely observed. Inspiratory elevation of the fluid level is not the result of diaphragmatic paralysis; it is the result of displacement of the mediastinum toward the hydrothorax (paradoxical phenomenon of Kienböck).

Suggestions are made for the differentiation of diaphragmatic pleurisy from phrenic paralysis. In diaphragmatic pleurisy the elevation is rapid and progressive. The superior limit of the opacity does not exactly parallel the diaphragmatic curve. Respiratory immobility is not of differential diagnostic value. On the other hand, normal movement eliminates phrenic paralysis. Injection of air results in an air-fluid level in pleurisy, and injection of Lipiodol results in an opaque layer beneath the surface of the pleural effusion.

Lateral decubitus views demonstrate the movement of free pleural fluid. Injection of air into the peritoneal cavity delineates the level of the inferior surface of the diaphragm.

Four roentgenograms; 2 drawings.

CHARLES NICE, JR., M.D., Ph.D.
University of Minnesota

THE MUSCULOSKELETAL SYSTEM

The Osseous Infarct. H. D. de Reus. J. belge radiol. **40:** 20–30, 1957. (In French) (Laboratoire de Radiologie de l'Hôpital Juliana, d'Apeldoorn, Netherlands)

Osseous infarcts occur in the metaphysis, epiphysis, or both. The most common sites are the proximal epiphyses of the humerus and femur, the femoral condyles, and the metaphyses of the humerus, femur, and tibia.

When the infarct is localized to an epiphysis, there is first produced a subchondral necrosis, the necrotic bone being then replaced by new bone or fibrous tissue, which may undergo calcification. Secondary arthroses are produced in the nearby joints. Similar necrotic change followed by new bone and calcifying fibrous tissue is seen in metaphyseal infarcts. The changes may extend into the diaphysis. There is no periosteal reaction. Small infarcts are difficult to detect radiologically because they are probably completely replaced by new bone.

Primary bone infarcts are seen in caisson disease and arteriosclerosis. Secondary infarcts are associated with fractures, inflammations, and tumors of bone. The etiology is often unknown, as in the cases presented by the author.

Much remains to be learned about the blood supply of bones and the pathogenesis of infarcts. Arteriography has failed to produce the desired information.

Two roentgenograms; 1 drawing.

CHARLES M. NICE, JR., M.D., Ph.D.
University of Minnesota

Periostitis Ossificans in Rheumatic Polyarthritis in Children. H. Hiltemann. Fortschr. a. d. Geb. d. Röntgenstrahlen **86:** 98–101, January 1957. (In German) (Ludgeristr. 7, Münster/Westf., Germany)

The author reports his observations on a 3-year-old girl with Still's disease. The roentgenograms made half a year after the onset showed a periosteal bony seam symmetrically disposed on the proximal phalanges of the second through the fifth finger. Two months later these same phalanges presented a double contour of the substantia compacta. After another two months, slight obliteration of the old compacta began, with changes in the phalanges from the normal slender tubulation to a plump conical contour. Initially, the soft-part swelling was diffuse and spindle-like. Only later was it localized around the joints.

Next to slight osteoporosis, periosteal reaction is the first roentgenologic sign of this disease in the skeleton. This occurs when the soft-part swelling is still diffuse, with no localization at the joint. It cannot be decided whether this periosteal reaction is the result of an advanced joint inflammation or whether the periosteum itself is inflamed in this stage.

Similar periosteal reactions are well recognized in infectious diseases, avitaminoses, and neoplasms. Localized periostoses are illustrated by Caffey in the metacarpals in the region of the inflamed carpal bones in

rheumatoid arthritis of childhood. The present observation indicates further that this reaction in the proximal phalanges is also an early sign of the disease.

Six roentgenograms; 1 photograph.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

A Study of the Early Conditions of Osteomyelitis in Young Children by the Röntgen Ray. Thomas Morgan Rotch and Arial Wellington George. Arch. Pediat. **74:** 33–36, January 1957.

This report of roentgen studies of osteomyelitis in young children, reprinted from Archives of Pediatrics for July 1907, was first read before the Nineteenth Annual Meeting of the American Pediatric Society twelve years after Roentgen's discovery of the rays bearing his name. The inestimable value of these rays in establishing early diagnosis in cases of osteomyelitis, with the possibility of preventing not only death, but resulting deformities which in some cases mean more than death, is pointed out and 4 cases are presented to illustrate the point. In conclusion the authors stated: "In all cases where the diagnosis is not clear, we should never disregard the fact that we have in the Röntgen method a means by which we can clearly understand the case and know at a very early period whether operation is indicated or not."

Primary Reticulum Cell Sarcoma of Bone. Robert Schobinger von Schowingen. Am. J. Surg. **93:** 41–49, January 1957. (Roswell Park Memorial Institute, Buffalo, N. Y.)

In a critical review of the world literature, 154 cases of primary reticulum-cell sarcoma of bone were found. The author adds a case in a 69-year-old white man. Except for the fact that it was seen after the usual age (fourth decade), the case fits the well established criteria for diagnosis. These are listed as follows: (1) primary focus in a single bone; (2) malignant character established by biopsy from the bone itself; (3) pattern histologically similar to other reticulum-cell sarcoma types; (4) a long natural history locally, without systemic manifestations; (5) metastatic lesions limited to regional lymph nodes and following the primary by not less than six months; (6) a high degree of radiosensitivity.

Roentgenograms, as a rule, show the tumor arising in the medullary cavity of the bone. The neoplasm tends to present itself predominantly as a destructive, osteolytic lesion. The initial extension of the tumor is within the bone rather than into the soft tissues and the involved area may present a patchy, mottled appearance. Arteriography is a valuable diagnostic measure. The technic of this procedure is described. It can be performed easily and, with proper precautions, is unattended by any untoward effects. The typical tumor stain, as observed in the case reported, is illustrated by roentgenograms demonstrating the arterial and venous phases. For a definite histologic diagnosis, biopsy is necessary.

Radiation therapy alone and surgery followed by irradiation are the most popular therapeutic approaches. The choice of procedure will be influenced, at least in part, by the local extent of the lesion and the existing symptoms. The survival rate tends to be favorable.

Three roentgenograms; 1 photograph; 1 photomicrograph.

J. E. RHODENBAUGH, M.D.
The Henry Ford Hospital, Detroit

Osseous Lesions in Urticaria Pigmentosa. Frederick G. Zak, Jerome A. Covey, and John J. Snodgrass. New England J. Med. **256:** 56–59, Jan. 10, 1957. (Manhasset, Long Island, N. Y.)

Urticaria pigmentosa is a chronic benign cutaneous disorder characterized by pigmented macules, papules, or nodules, and microscopically by increased numbers of mast cells in the skin. Both visceral and skeletal involvement have been reported.

A case with widespread osseous lesions is reported. The patient, a 58-year-old white female, entered the hospital complaining of weakness, nervousness, vomiting, diarrhea, and weight loss. The past history showed intermittent attacks of an urticarial nature during the preceding two years, with persistence of the skin lesions over the trunk and proximal extremities. Extensive clinical and laboratory studies were done. From the radiologic aspect the important observation was a demineralized or moth-eaten appearance of the bones of the spine, thorax, and pelvis. The lesions are described as follows: "The bones were diffusely involved in a combined osteolytic-osteoblastic process. There were multiple small mottled lucent areas with intermingled tiny nodular areas of increased bone density. The appearance was not that of simple osteoporosis but was highly suggestive of metastatic neoplasm." Biopsy of the skin showed the characteristic infiltration of subcutaneous tissues with large numbers of mononuclear cells with metachromatic cytoplasmic granules, or mast cells. Bone biopsy from the iliac crest also showed an infiltrate of nongranular mononuclear cells replacing the normal marrow and interpreted as immature or postmature mast cells.

One roentgenogram; 3 photomicrographs; 1 photograph.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Roentgenologic Aspects of Motor Vehicle Accidents. Jacob Kulowski. Am. J. Roentgenol. **77:** 115–130, January 1957. (2515 Francis St., St. Joseph, Mo.)

The author reviews in considerable detail those factors important in the prevention of motor accidents, physical factors in injuries, and the management of injured patients, from the point of view of immediate diagnostic and therapeutic measures, and later follow-up procedures in rehabilitation and evaluation of residual injuries. Radiology pervades the entire field and interlocks with every facet of it.

From the radiological aspect, several interesting and important points are brought out. It is now evident that certain pre-existing conditions not only predispose to more severe injuries, but actually result in increased incidence of automobile accidents. In this respect, cervical arthritis (hypertrophic or traumatic degenerative arthritis) seems most important. Persons with such arthritis not only suffer more severe injuries to the cervical spine but actually seem more prone to be involved in rear-end and/or angular vehicular collisions.

In addition to these preclinical considerations, there are some physical factors governing accidents and injuries which the author designates as paraclinical. Under this heading he takes up features of car construction and certain physical conditions in those involved in the accident. "Roentgenographic screening will bring many conditions to light which could lead to so-called pathologic (fractures) injuries. . .osteoporosis of the spine, cystic and other destructive bone lesions, and herniated lumbar disks."

With regard to management during the acute stage of injury, the point is made that the radiologist should instruct referring physicians as well as his own technicians on the dangers of rough handling of patients and of unnecessary movement. It is felt that as soon as primary shock has been treated and reasonably well controlled, the time for diagnostic roentgen study is at hand. The complexity of the studies undertaken must be individualized to the patient's injury pattern and his general condition. The radiologist should be alerted in particular to chest injuries, especially those involving the heart, pericardium, and great vessels. Such injuries are frequently not adequately demonstrated on scout-type chest films so that fluoroscopy of patients, even though seriously ill, must be considered. There is now good evidence that chest trauma makes up the most important group of lethal injuries, having superseded those of the head and neck.

The radiologist's responsibilities also extend into the recovery and rehabilitation periods, particularly in respect to evaluation of residual injuries from a medicolegal standpoint. Evaluation of pre-existing conditions and their possible aggravation is another aspect.

Thirty-one figures; 4 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

The Roentgen Features of Fibrous Dysplasia of the Skull and Facial Bones. A Critical Analysis of Thirty-Nine Pathologically Proved Cases. John William Fries. Am. J. Roentgenol. **77:** 71–88, January 1957. (St. Anthony's Hospital Grand Blvd. and Chippewa St., St. Louis 18, Mo.)

The author reviewed 39 microscopically verified cases of fibrous dysplasia of the skull or facial bones, collected from institutions and individuals from various localities throughout the United States. The pathologic examination suggests that the basic tissue disturbance exists in bone, whereby fibrous tissue has the ability to form bone directly (metaplasia). When fibrous dysplasia involves the skull or facial bones, the roentgen examination shows three forms to be distinguishable:

1. *Pagetoid*, so named because of its roentgen similarity to Paget's disease. The involved area is expanded and shows alternate areas of density and radiolucency. The skull may attain a thickness of more than 7 cm. Most of the expansion is outward, with thinning, erosion, and disappearance of the outer table. Osteoporosis circumscripta does not occur.

2. *Sclerotic*. In this form the lesions present a homogeneously dense area of involvement. Expansion of the bone is also noted, the outer table of the skull being most involved, though the inner table may be affected to an equal degree.

3. *Cyst-like*. The lesions are round or oval and are usually single, with a dense border that is thin and distinct. They average between 2 and 5 cm. in diameter, and both tables of the skull may be involved. Only one of the author's cases involved the facial bones.

The pagetoid type is the most common, shows the most extensive involvement with reference to the number of bones, occurs in a slightly older age group, and presents symptoms of longer duration.

In 11 cases (28 per cent) of the series, a single skull or facial bone was involved, and in 28 cases (72 per cent) there was multiple bone involvement.

The most common symptom was swelling or asymmetry of the head or face, occurring in 31 patients (79 per cent).

Twelve patients showed unilateral proptosis. In all of these cases the frontal bone was involved and in 11 the sphenoid bone as well.

Six patients presented nasal symptoms, the most common being obstruction. In all 6 the ethmoid bone was involved, and in 5 cases the lacrimal bone.

Severe mental disturbances were observed in 2 patients with extensive frontal bone changes. Bony encroachment on the frontal lobes with resultant atrophy is the logical explanation.

Thirteen roentgenograms; 2 photomicrographs; 2 photographs; 2 tables. THEODORE E. KEATS, M.D.
University of Missouri

Chronic Neurological Sequelae of Acute Trauma to the Spine and Spinal Cord. Part I. The Significance of the Acute-Flexion or "Tear-Drop" Fracture-Dislocation of the Cervical Spine. Richard C. Schneider and Edgar A. Kahn. J. Bone & Joint Surg. **38-A:** 985–997, October 1956. (Department of Surgery, University of Michigan Medical School, Ann Arbor, Mich.)

Among the acute injuries of the cervical spine, the acute flexion or tear-drop type of fracture-dislocation has received only scant attention. This lesion is characterized by crushing of a vertebral body by the one superior to it in such a manner that the anterior part of the involved centrum is not only compressed but often is completely broken away from its major portion. In most cases, this fragment has resembled a drop of water dripping from the vertebral body, and the terms "tear-drop" and "acute-flexion" fracture-dislocation of the cervical spine seem to describe the lesion and to suggest the mechanism of the injury. The most important feature of this injury is the displacement of the inferior margin of the fractured vertebral body backward into the spinal canal, often causing compression or destruction of the anterior portion of the cervical spinal cord. Recognition of the lesion is important from the standpoint of treating the immediate sequelae of the initial injury and for the prevention of a chronic neurological deficit which may occur years after the traumatic episode if proper therapy is neglected.

Cases of acute-flexion tear-drop fracture-dislocation with a neurological deficit should be treated by traction; surgical exploration by laminectomy should be performed with the patient in traction and the dentate ligaments should be sectioned. Finally, but extremely important, fusion of the involved portions of the cervical spine in good alignment should be performed. This may be done either at the initial surgical procedure or, preferably, at a second operation. In the case of tear-drop fracture without neurological signs, spinal fusion without laminectomy should be performed after spinal realignment by cervical traction.

Five cases demonstrating various phases of the problem and indicating the varying degrees of chronic compression of the anterior portion of the cervical spinal cord are presented.

Fifteen roentgenograms; 2 drawings.

A Calcified Thoracic Intervertebral Disk with Herniation and Spinal Cord Compression in a Child. Case Report. Fremont C. Peck, Jr. J. Neurosurg. **14:** 105–109, January 1957. (47 S. Lake Ave., Albany 3, N. Y.)

The author reports a case of calcified nucleus pulposus

at the level of T-6 with rupture into the spinal canal and signs of cord compression. The patient was a twelve-year-old boy. The condition is rare, especially so in children. The calcification may be transient, disappearing spontaneously without active surgical measures. Operation should be undertaken when there is roentgen evidence of posterior extrusion into the spinal canal, with clinical or myelographic indications of cord compression.

The calcification occurring in the nucleus pulposus in childhood resembles peritendinitis calcarea in the adult.

Four roentgenograms. GORDON L. BARTEK, M.D.
Grand Rapids, Mich.

Annulo-Meningeal Interval. Donald deF. Bauer and Norman M. Harris. Northwest Med. **56:** 51–54, January 1957. (D. deF. B., North Bend, Ore.)

The annulo-meningeal interval (AMI) was measured in 38 cases of suspected intervertebral disk disease in which both myelograms and discograms were obtained. This interval is defined as the space between the posterior border of the annulus of a disk and the anterior border of the contrast column in the subarachnoid space at the same level. It was found that when the AMI exceeds 4 mm. at L-4 or 6 mm. at L-5, the chance of finding a posterior herniation by discography after a negative myelogram is increased. Therefore, a negative myelogram in the presence of a long AMI is of limited reliability in ruling out herniated disks.

Twenty-three roentgenograms; 2 photographs; 1 table. RICHARD H. GREENSPAN, M.D.
University of Minnesota

Spondyloschisis Following Spine Fusion. Carl E. Anderson. J. Bone & Joint Surg. **38-A:** 1142–1146, October 1956. (1150 Montgomery Drive, Santa Rosa, Calif.)

A case of spondyloschisis occurring spontaneously in an apparently intact fourth lumbar vertebra following fusion of the lumbosacral spine is reported. The patient was a 36-year-old woman. The cause of the spondyloschisis in this case is not known, but it is suggested that it resulted from the unusual stress associated with fusion of the spine at a lower level. It seems improbable that any direct operative trauma to the involved neural arch or its blood supply could have caused the phenomenon, for the isthmic area was not disturbed in the operation and no bone was removed from the neural arch. One other case of spondyloschisis occurring in a similar manner has been recorded (Unander-Scharin: Acta orthop. scandinav. **19:** 536, 1950). These 2 cases indicate that defects through the isthmic portion of a previously normal lumbar vertebra may occur in an adult without severe trauma.

Eighteen roentgenograms.

Malformations of the Occipitovertebral Joint. E. P. Naudin and P. F. Girard. J. de radiol. et d'électrol. **38:** 1–12, January-February 1957. (In French) (Lyons, France)

In spite of their relative rarity, the recognition of malformations of the occipitovertebral joint is important. Clinical manifestations in the bulbo-medullo-cerebellar region necessitate careful attention to the bony constitution of the joint. At times, the roentgenologic diagnosis is evident on plain films, while at other times, the condition may be obscured by the petrous pyramids. Tomography may be of aid.

There are four principal types of malformation: platybasia, basilar invagination, assimilation or fusion of the atlas with the occipital bone, and occipital vertebra. Some features indicate special severity: these include atlo-axoid dislocation and signs of increased intracranial pressure.

Sixteen roentgenograms.

CHARLES M. NICE, JR., M.D., Ph.D.
University of Minnesota

Giant-Cell Tumor of Cervical Vertebra with Unusual Symptoms. Report of a Case and Review of the Literature. Eugene M. Regen and Arnold Haber. J. Bone & Joint Surg. **39-A:** 196–200, January 1957. (407 Medical Arts Bldg., Nashville 12, Tenn.)

A case of giant-cell tumor of the third cervical vertebra is considered of interest because of the single presenting symptom of dysphagia and because of the rarity of vertebral involvement by this neoplasm.

A twenty-eight-year-old white female consulted her physician because of difficulty in swallowing, which had become progressively more severe during the prior six months. Physical examination revealed a retropharyngeal mass. Biopsy proved it to be a giant-cell tumor. Radiographs showed destruction of the body of C-3.

The lesion was treated with deep x-irradiation, a total of 4,800 r being administered through two lateral portals. The mass disappeared and swallowing function returned to normal, though the bone lesion was not grossly altered. Three months later a fusion operation of the cervical spine extending from the second through the fifth cervical vertebra was performed. Two years after this the patient was symptom-free. No further destruction of bone was noted.

An excellent discussion as to diagnosis and treatment of giant-cell tumor concludes the presentation.

Three roentgenograms; 1 photomicrograph.

JOSEPH P. TOMSULA, M.D.
Baton Rouge, La.

The Effects of Pressure on Epiphyseal Growth. The Mechanism of Plasticity of Growing Bone. Alvin M. Arkin and Jacob F. Katz. J. Bone & Joint Surg. **38-A:** 1056–1076, October 1956. (Orthopedic Services, Mt. Sinai Hospital, New York, N. Y.)

All skeletal growth in *length* (except for bones laid down in fibrous tissue) is cartilaginous. This growth may occur in the epiphyseal plate, in the cartilaginous articular surfaces at the bone ends, at the apophysis, in the vertebral ring, or in the vertebral diaphyseal growth plate. Whatever the site, the increased length is added by multiplication of cartilage cells, these cells being later converted into bone by enchondral ossification. Growth in *thickness*, on the other hand, always occurs by the addition of new bone tissue to free bone surfaces, a process which has been called "appositional bone growth."

The effect of pressure on these two types of bone growth differs. Appositional growth is stimulated. Thus, increased weight-bearing will result in increased thickness and density of the shaft of the tibia, a response which makes the bone better able to resist the stress which causes the response. Epiphyseal growth, on the other hand, yields to pressure, and this behavior is the principal mechanism in the plastic response of bone.

Pressures as applied to the epiphysis can be classified into one of two main types—those parallel to the direction of epiphyseal growth and those at right angles to it.

The authors describe an experimental study of the behavior of the growth cartilage in response to these two types of stresses. The animals used in this project were young rabbits, six to eight weeks of age. In each animal pressure was applied to the growing epiphysis by means of a plaster cast which held the left hind leg in the desired attitude of deformity. The following observations were made:

1. When a growing epiphysis is subjected to a stress, the rate or direction of the growth of that epiphysis, or both, are modified so as to yield to that stress.

2. Pressures applied in directions parallel to the direction of epiphyseal growth inhibit the rate of such growth. While considerable pressures are necessary to stop cartilaginous growth completely, slight or even intermittent pressures can slow or hinder it. The gravitational pressures of normal weight-bearing seem to slow cartilaginous growth in vertical weight-bearing bones; escape from normal weight-bearing stresses results in overgrowth.

3. Pressures applied in directions perpendicular to the direction of epiphyseal growth deflect the direction of such growth, resulting in lateral or spiral (torsional) displacement of the newly laid-down bone.

The ease with which angular or torsional deformities may be produced in a growing bone varies inversely with its diameter. The narrower the bone, the greater its "plasticity."

Twenty-seven figures, including numerous roentgenograms.

The Effect of Staples and Longitudinal Wires on Epiphyseal Growth. An Experimental Study. Robert S. Siffert. J. Bone & Joint Surg. **38-A:** 1077–1088, October 1956. (Department of Orthopedic Surgery, Mt. Sinai Hospital, New York, N. Y.)

In order to determine the histologic response to two forms of metal fixation employed in children for correction of unequal leg length, namely, stapling and the use of transepiphyseal wires, the authors carried out two series of experiments on rabbits. The first series was designed to ascertain the mechanism of epiphyseal growth inhibition and eventual epiphyseodesis under staples. The effect of stapling is a direct pressure inhibition of the proliferating stage of epiphyseal growth. The cartilage cells of the epiphyseal plate, however, continue their maturation so that the hypertrophic cells degenerate, the palisading cells hypertrophy and eventually degenerate, and finally the proliferating and resting cells pass through a similar sequence. The metaphyseal vascular channels, with the accompanying osteoblasts, invade each successively degenerating group of cartilage cells, thus gradually thinning the epiphyseal plate until eventual epiphyseodesis occurs.

Three histologic changes are visible roentgenographically: (1) disappearance of the fine metaphyseal trabeculae, (2) formation of a dense layer of subepiphyseal bone, (3) thinning of the epiphyseal plate. It is suggested that roentgenograms of stapled epiphyses in which growth has not been resumed after the staple was removed be restudied to determine their value clinically in forecasting premature closure of the epiphyseal plate under a staple.

In the transepiphyseal wire experiments it was observed that when a wire traversed the epiphyseal plate there was no interference with longitudinal growth. As the epiphysis grew beyond the wire, the transepiphyseal defect made by the wire was replaced by bone; the epiphyseal defect showed no signs of being replaced by epiphyseal cartilage cells. The degree of deformity depended upon the location of the epiphyseodesis and its extent.

Crossed wires were not an effective means of epiphyseodesis.

Since there is a great similarity between these findings in rabbits and many clinical experiences, some of the observations may be of value in throwing light on the problem of epiphyseal growth arrest and deformities due to abnormal epiphyseal plate growth.

Seven roentgenograms; 10 photomicrographs.

Bilateral Undescended Scapula Associated with Omovertebral Bone. Report of a Case. John D. Blair and Paul O. Wells. J. Bone & Joint Surg. **39-A:** 201–206, January 1957. (Letterman Army Hospital, San Francisco, Calif.)

The authors report a case in which unusually well developed omovertebral bones coexisted with an anomaly of the cervical spine. Despite the pronounced changes, almost no loss of normal useful function existed. The patient was a nineteen-year-old colored boy.

The omovertebral bones lay just under the skin and were easily palpable. Each felt like a well formed, slender shaft-type bone with slightly enlarged rounded ends. The distal ends lay at about the middle of the vertebral borders of the scapulae when the patient stood relaxed, and the proximal ends lay side by side at the level of the spinous processes of the fifth and sixth cervical vertebrae. Upon abduction, forward extension, and elevation of the arms, the vertebral borders of the scapulae could be felt to move, this movement separating them from the distal ends of the omovertebral bones.

Roentgenographic examination demonstrated anomalies of both shoulder girdles and of the cervical spine. The right scapula was elevated, and its supraspinatous portion was curved anteriorly in a manner characteristic of Sprengel's deformity. The vertebral border of the scapula was irregularly convex, with a shallow concavity in its midportion, where it adjoined a well developed omovertebral bone. The proximal end of the right omovertebral bone was flared and attached to the laminae of the fifth and sixth cervical vertebrae. A narrow cleft was noted in the neural arch at this level.

Similar changes were present on the left side except that the proximal end of the omovertebral bone was attached primarily to the arch of the fifth cervical vertebra. The cervical spine showed an additional anomaly consisting in posterior displacement of the odontoid process of the second cervical vertebra in relation to the anterior arch of the first cervical vertebra.

An excellent discussion of so-called "Sprengel's deformity" is included.

Three roentgenograms; 2 photographs.

JOSEPH P. TOMSULA, M.D.
Baton Rouge, La.

Effects of Strontium and Fluoride on the Repair of Unreduced Humeral Fractures in the Adult Rat. William B. Savchuck. J. Bone & Joint Surg. **39-A:** 140–152, January 1957. (National Institute of Dental Research, Bethesda, Md.)

Strontium and fluoride are avidly taken up by the osseous tissues. Both of these substances can be accommodated in the bone-crystal lattice, and since the two ions are of opposite charge, theoretically they should not compete for the same positions in the crystal

structure. The literature suggests that strontium is well retained by the skeletal system and that it may possess certain advantages over calcium in remineralization of the depleted human skeleton. Like strontium, fluoride also is readily deposited in the skeleton, where it is so fixed that its elimination is limited.

In the work reported here, the unreduced fractured left humerus of the adult male rat was used as a test bone to study the influence on bone repair of strontium and fluoride, alone and in combination. Some aspects of the healing of this type of fracture were studied (1) autoradiographically, (2) chemically, (3) physically, and (4) histologically.

The author's own summary affords an excellent review of results.

"1. In a fracture study of twelve selected adult rats, autoradiograms (with use of Sr^{89}) showed that ossification seems to progress centripetally toward the interfragmentary space, and is generally more pronounced about the concavity of an unreduced fracture. The most extensive deposition of strontium in the callus appeared at about four weeks after fracture. A noticeable drop in strontium uptake by the fractured humerus appeared at about ten weeks.

"2. In a limited chemical study of strontium deposition with a select group of twelve adult rats, findings were as follows:

"a. An elevated fluoride intake did not favor increased accumulation of strontium either in the fractured humeri or in the sound humeri and femora.

"b. The percentage of strontium taken up by the fractured unreduced adult rat humerus was twice that deposited in the sound limb, the increase being attributable chiefly to uptake by the callus. This ratio dropped appreciably toward the end of the repair period.

"c. Judging by the comparative uptakes of the femora and sound humeri, the relative distribution of strontium among the femora and humeri of an individual animal (calculated as percentage of strontium) appeared to be related to the mineral content of these unfractured bones.

"3. The reliability of measurements of relative breaking strengths of rat bones on a specially devised static-loading assembly has been demonstrated, and results were found to be satisfactory when an average absolute deviation of 6 per cent was tolerable.

"4. From the sixth through the twelfth week after unreduced fracture of the left humerus, adult rats on a stock diet received as drinking fluids solutions of strontium, fluoride, a combination of these, or distilled water.

"a. Under the conditions of this experiment strontium, fluoride, or a combination of the two showed no significant effect upon the breaking strength of the fractured member.

"b. There seemed to be no clear relation between the breaking strength of the repaired humerus and its roentgenographic appearance, histological findings, or the mineral regimen.

"5. A constant intake of strontium, fluoride, or strontium fluoride over 180 days did not show any significant influence of these minerals (in the concentrations used) upon fracture resistance of the humerus and tibia or upon longitudinal growth of the long bones of adult rats."

Three autoradiographs; 3 photomicrographs; 1 photograph; 1 diagram; 4 tables.

JOSEPH P. TOMSULA, M.D.
Baton Rouge, La.

Two Unusual Dislocations at the Wrist. Harold Seidenstein. J. Bone & Joint Surg. **38-A**: 1137–1141, October 1956. (1749 Grand Concourse, New York 53, N. Y.)

The author reports 2 cases of unusual dislocations at the wrist—one, an acute anterior dislocation of the ulna, the other, a posterior subluxation of the lunate.

Acute Anterior Dislocation of the Distal Extremity of the Ulna: This condition presents a very characteristic and striking deformity. The wrist appears peculiarly narrow, and the hand looks as if it were perched on an apex of the forearm, instead of on the normal broad oval of the wrist. The distal end of the ulna is absent from its position on the side of the wrist. It is this disappearance of the bony prominence of the ulna that accounts for the narrowed appearance of the wrist. When viewed from the side there is no undue prominence of the distal end of the ulna because the head is deep in the flexor tendons and is buried in the soft tissues. A thickening can be felt in the front of the wrist where the head of the ulna is located.

Roentgenograms of the wrist are curiously deceptive. The distal end of the ulna is moved anteriorly and somewhat radially, so that in the anteroposterior position there is more overlap of the radius and ulna than in the normal wrist. This can easily be misinterpreted as being an oblique roentgenogram of the wrist joint; however, if an anteroposterior view of the opposite wrist is made at the same time, one can see the extent to which the ulna overlaps the radius. In the lateral view the distal end of the ulna is anterior to the radius, so that the dorsal cortex of the ulna lies in front of the volar cortex of the radius.

The mechanism of this injury is not clear, but it is apparently due to hypersupination.

Posterior Dislocation of the Lunate without Fracture: The clinical deformity resulting from posterior dislocation is not striking. The wrist appears somewhat larger than normal, with mild swelling on the dorsum.

Roentgen examination shows marked and significant changes in the organization of the carpal bones. In the anteroposterior projections, one can see that the capitate has moved proximally and has spread the navicular and triquetrum apart. This appearance in the anteroposterior view is characteristic of any dislocation of the lunate. The lateral and oblique views are somewhat more difficult to interpret, but better indicate the true pathological picture. It is apparent that the lunate is not displaced in the volar aspect of the wrist and there is an abnormal prominent bone on the dorsum of the wrist. This is somewhat more clearly demonstrated by the oblique view, which shows the lunate to be situated dorsally.

The mechanism of this injury is apparently the reverse of forward dislocation of the lunate. In posterior dislocation, the wrist is hyperflexed and the lunate is pushed out dorsally.

Ten roentgenograms.

The Carpal-Bridge View; a Position for the Roentgenographic Diagnosis of Abnormalities in the Dorsum of the Wrist. Walter Lentino, Herman W. Lubetsky, Harold G. Jacobson, and Maxwell H. Poppel. J. Bone & Joint Surg. **39-A**: 88–90, January 1957. (W. L., Department of Radiology, New York University College of Medicine, New York, N. Y.)

An additional view for more complete examination of the wrist is described. This view is especially worth-

while for visualization of foreign bodies or fracture deformities occurring on the dorsal aspect of the carpal area.

The patient is seated, with the arm of the wrist to be examined perpendicular to the body and the forearm perpendicular to the table. The hand lies palm upward directly on a cardboard cassette. A triple right angle is thus formed: the arm forms a right angle with the body, the forearm forms a right angle with the arm, and the hand forms a right angle with the forearm.

The central ray of the roentgen beam is adjusted at an angle of 45° with the table top and enters the wrist 2 inches above the table top. The exposure factors for an average wrist are: 100 ma, one and one-half seconds, 50 kv, 36 inches target-film distance, with a cardboard cassette and a cone.

Five roentgenograms; 1 diagram.

JOSEPH P. TOMSULA, M.D.
Baton Rouge, La.

Early Diagnosis and Pathogenesis of Congenital Dislocation of the Hip. W. Frischknecht. Schweiz. med. Wchnschr. **87:** 64–66, Jan. 19, 1957. (In German) (Säuglings- und Kinderheim "Tempelacker," St. Gallen, Switzerland)

Congenital hip luxation is the sequel of dysplasia and some degree of hypoplasia of the bones, cartilages, capsule, and periarticular soft-tissue structures of the hip joint. Early recognition of the anomaly is essential. Reduction within the first six months results in a normal acetabulum in 80 per cent of the cases; reduction within twelve months results in a normal acetabulum in 70 per cent of the cases. Reduction after the third year is followed by a deformed acetabulum and later osteoarthritis.

Twenty-two cases are analyzed and tabulated. Five patients were males, 17 were females. In 16 of the series involvement was bilateral; in 12 there were other anomalies. Seven cases were associated with neurological symptoms.

Early signs up to three months: A "snapping" in the hip upon flexion and internal rotation. This "reduction phenomenon" should be systematically looked for in obstetrical wards.

Signs up to four months: (1) Limitation of abduction of the flexed femur in supine position. This is the most diagnostic sign. Normally the knee should descend within four fingers of the table top. Adductor spasm due to cerebral palsy is to be differentiated.

(2) Signs of asymmetry, as foreshortening of the leg, prominent trochanter, increased adductor folds, asymmetry of gluteal and inguinal folds and the labia majora. These signs hold only in the less frequent unilateral cases.

(3) Increased external rotation and increased mobility, permitting diagonal positioning of the femur toward the opposite axilla.

Late signs, from the fourth month: Radiographic signs assume more significance as the child grows older, in particular after calcification of the capital epiphyses, in the fifth to sixth month in females and in the seventh month in males. In the newborn, the acetabular angle may normally be 35° and greater. Beginning with the fourth month, an angle of more than 30° is suggestive of dysplasia. The well known auxiliary geometrical schemes are useful in the recognition of dysplasia, even before ossification of the capital epiphyses. The roentgen signs are not discussed.

The diagnosis was made in 20 out of the author's 22 cases by clinical determination of diminished abduction, in 2 newborn infants by the "reduction phenomenon." Routine clinical examination, including the observation of the above signs, is stressed because the diagnosis is possible long before the parents notice any abnormality. The diagnosis should be confirmed by radiography in all cases because of the high incidence of concomitant functional or organic neurogenic muscle hypertony.

Three roentgenograms; 1 photograph; 1 table.

GUENTHER A. DOEHNER, M.D.
St. Vincent's Hospital, N.Y.

Hypercholesteremic Xanthomata of the Tendons. Herman C. March, Philip D. Gilbert, and Thomas M. Kain. Am. J. Roentgenol. **77:** 109–114, January 1957. (H. C. M., 7222 Castor Ave., Philadelphia 49, Penna.)

Hypercholesteremic xanthomata of the tendons is one of a group of systemic diseases making up the lipidoses. It is a familial condition and is not related to the more common xanthomata or giant-cell tumors of tendon sheaths. The latter is not a systemic disease and has other distinguishing features.

Hypercholesteremic xanthomata tend to occur on extensor surfaces, particularly on the dorsal aspects of the fingers and toes and very characteristically in the Achilles tendons. On roentgenography the lesions present as sharply defined thickenings of aqueous rather than fatty density. Occasionally the immediately adjacent bone is involved, with small rounded or punched-out defects in the cortex, caused by pressure destruction from the tumor. Such lesions are most commonly seen in the small bones of the hands. Ordinarily there is little if any surrounding bone reaction.

The tumor lesions vary from 2 mm. to several centimeters in diameter. The principal condition to be differentiated is gout. The roentgen manifestations may be very similar in the two diseases, but there is little difficulty in differentiation on other grounds. The point is made that the bone defects of tendon xanthomatosis show a tendency *not* to involve the articular margins of the joints in contradistinction to the lesions of gout. Occasionally neurofibromatosis may produce a similar picture.

Brief report is made of three cases, occurring in two families.

Twelve roentgenograms; 2 photographs.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

THE SPINAL CORD

Intradural Lipomas of the Spinal Cord, with Particular Emphasis on the "Intramedullary" Lipomas. Pedro C. Caram, Giuseppe Scarcella, and Charles A. Carton. J. Neurosurg. **14:** 28–42, January 1957. (C. A. C., Montefiore Hospital, New York 67, N. Y.)

The fiftieth and fifty-first cases of spinal lipoma are reported and details of these and the 49 cases previously published are presented in tabular form. On plain film there was a widening of the spinal cord with erosion of the pedicles in 1 case. In the other case the plain films were not remarkable, but the myelogram showed a complete block at the level of the lipoma.

A general discussion of the condition is presented.

Six illustrations, including 3 roentgenograms; 2 tables.

GORDON L. BARTEK, M.D.
Grand Rapids, Mich.

GYNECOLOGY AND OBSTETRICS

Aortography: The Safest Means of Placental Localization? A Preliminary Report. P. D. de Villiers and Donald Brink. South African M. J. **31:** 37–40, Jan. 12, 1957. (King Edward VIII Hospital, Durban, Union of South Africa)

The authors consider retrograde aortography to be the safest method of placentography available. Catheter replacement of the needle, as described by Seldinger (Acta radiol. **39:** 368, 1953. Abst. in Radiology **62:** 466, 1954) has so simplified the procedure that it is applicable even in the small department.

The examination is performed under local anesthesia forty-five minutes after administration of 100 mg. of pethidine. The catheter is measured before its introduction with a linen tape, sterilized with the rest of the apparatus. In most patients, 9 inches of catheter introduced will reach above the level of the aortic bifurcation, yet lie well below the important branches of the aorta. Measurement of the catheter before introduction dispenses with the need for a preliminary exposure of mother and child to determine its position. Baumanometer cuffs are applied above both knees and inflated to a pressure higher than arterial pressure just before the medium is injected. A hand injection of 20 to 25 ml. of 50 per cent Diaginol (sodium acetrizoate) is made as rapidly as possible.

A single picture taken one and a half to two seconds after completion of the injection usually indicates the placental site clearly. It demonstrates the rather star-like sinusoids characteristic of the placenta, and shows them all the more clearly because the large arteries have already emptied sufficiently not to obscure them. Films taken at various intervals have shown the contrast to persist in the sinusoids up to ten seconds after the injection, but to fall off rapidly after six to seven seconds. The early arterial phase, during the first second after completion of injection, produces a less convincing picture of the placental site than does the sinusoidal phase. The anteroposterior position is preferred because it appears that the placenta usually develops on the anterior or posterior rather than on the lateral uterine wall, perhaps because it has a bilateral blood supply.

In a series of 25 cases, 1 error in diagnosis has occurred, before the present timing of the film had been established. All patients were over 28 weeks pregnant, with bleeding of minimal or moderate severity, of unexplained etiology. Patients with severe hemorrhage were not included in the series because they are usually examined vaginally in the operating room by the obstetrician.

The reliability of these results will still have to be assessed by a careful follow-up of a large number of cases.

Four roentgenograms.

THE GENITOURINARY SYSTEM

The Value of Cysto-Urethrography in Paraplegia. M. Damanski and A. Sutcliffe Kerr. Brit. J. Surg. **44:** 398–407, January 1957. (Liverpool Regional Paraplegic Unit, Promenade Hospital, Southport, England)

All patients with complete or incomplete paraplegia suffer from retention of urine. Even if satisfactory autonomous or assisted voiding occurs, there is often a high residual urine, with consequent danger of infection. Routine retrograde cysto-urethrography is advised to assess the damage done by infection and to record any obstructing conditions for diagnosis, treatment, and follow-up care.

Routine anteroposterior and oblique views are obtained after filling with 8 oz. of 10 per cent sodium iodide, the oblique film being necessary for proper evaluation of the bladder neck and posterior urethra. Films obtained at rest are followed by films made during micturition. A delayed film is taken for evidence of ureteral reflux. Infection produces varying degrees of bladder trabeculation and one may see filling of dilated prostatic ducts or abscess cavities. Reflux to the renal pelvis with dilatation is a bad prognostic sign.

The radiographic appearance of the bladder and posterior urethra in the normal state and in paraplegia is described. Contraction of the entire posterior urethra is often seen; patients with lower motor neurone lesions frequently show relaxation of the proximal or distal portions of the prostatic urethra. The external sphincter in the membranous urethra may be relaxed or contracted. Most paraplegic patients also have angulation at the junction of bladder and urethra, seen best on the oblique view, and often there is a posterior filling defect due to a median bar or a completely encircling contracture of the bladder neck.

Cysto-urethrography has been found useful in establishing the indications for treatment in paraplegic patients—pudendal neurectomy, intrathecal alcohol block, or bladder neck resection. In some instances it is necessary to do two or all three of these procedures before a satisfactory result is obtained. Illustrative cases are reported, with 21 roentgenograms.

LAWRENCE A. POST, M.D.
University of California, S. F.

The Image Amplifier in Pediatric Studies. Part II: Motility and Emptying Activity of the Kidney Pelvis and Calyces. W. Catel and R. Garsche. Forstchr. a. d. Geb. d. Röntgenstrahlen **86:** 66–74, January 1957. (In German) (Univ.-Kinderklinik Kiel, Kiel, Germany)

This work is in line with the authors' previous studies on the lower esophageal segment, using a technic involving cinematography and image amplification, for which they have coined the term *Bindwandler*.

Intravenous pyelographic studies were done on four school children ranging from ten to fourteen years of age, to determine the motor pattern of the upper collecting system. True peristaltic waves were never observed in the kidney pelvis or its calyces. Motor activity is effected through change in tonus. Increased tonus in the infundibula leads to either ring-like or segmental narrowing, and in the pelvis to concentric narrowing, at times even to complete obliteration of the lumen.

The motor activity involved in emptying the calyces and pelvis of urine is neither uniform nor simple. This activity can be divided into three forms:

1. The kidney pelvis and calyces are dilated with urine which passes through the open ureteropelvic junction into the ureter. There is no localized narrowing nor occlusion. Only at the fornices is there a pendulum rhythm resembling an incomplete systole and diastole which aids the effective glomerular filtration pressure in propelling the urine from the papillary ducts. This is the commonest pattern of motor activity in the upper collecting system.

2. The points of entrance of all three or at least the upper two calyces into the pelvis are segmentally com-

pletely occluded, and a concentric increase in tonus leads to diminution in the size of pelvis, wherewith the urine is ejected into the ureter. This increase in tonus never was observed to lead to complete obliteration of the pelvic shadow.

3. A calyx contracts quickly and empties its contents through the moderately dilated pelvis into the remaining calyces being isolated from the pelvis by a contraction ring. Repeatedly, the upper and middle calyceal systems show a different functional state from the lower: If this latter is contracted, both upper ones are relaxed, and vice versa. However, there is a synchronous behavior pattern in all three calyceal systems.

The first of these three patterns of motor activity is the most common, but is least effective in expelling the urine into the ureter. The second and third are less common but are associated with greater propulsive effects. The first is continuous and the second and third are periodic.

Occasionally, retrograde movement of the urine from the pelvis into the lowermost calyceal system was observed. At that time, there was almost complete contraction of the pelvis while the sites of exit into the ureter and into the other calyces were closed.

[One may be somewhat dubious about generalizations based on so small a series.—Ed.]

Ten roentgenograms; 1 photograph; 1 table.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

MISCELLANEOUS

Roentgen Findings in Progressive Scleroderma. E. Nägele. Radiol. clin. **26:** 1–12, January 1957. (In German) (Röntgenabteilung der Medizinischen Poliklinik, Giessen, Germany)

The author presents a good summary of the pathological-radiological features of scleroderma based upon 10 cases.

Lungs: One-fourth of the patients with scleroderma have a radiologically detectable fibrosis of the lungs. Histologically, this is an interstitial connective-tissue proliferation with infiltration of lymphocytes, plasma cells and polymorphonuclear cells, with widening of the alveolar septa. An obliterative endarteritis may be associated. The pulmonary fibrosis may exist either with or without cysts.

Initially, the radiological changes, consisting of a striate-reticular pattern, are found especially in both lower lung fields near the diaphragm, the lateral and apical portions of the lungs remaining relatively free. Later, the fibrosis involves the midlung fields and especially the hilar areas. Pleural pericardial thickenings appear. Infection and even bronchiectasis can complicate the poorly vascularized and aerated segments. At this time, dyspnea can be expected. This results not from hardening of the skin and musculature of the thoracic wall, as formerly thought, but predominantly from changes in the lungs themselves.

Heart: Extensive disseminated mild cardiofibrosis, as well as pericardial obliteration and pleural pericardial adhesions, can be found. The roentgenogram often reveals a normal heart shadow, but many times a generalized enlargement can be detected, which may at times assume a triangular form similar to a pericardial effusion. This rare pattern is not caused by an effusion, but by pleural pericardial adhesions. At times the roentgenogram discloses a marked cor pulmonale. Electrocardiographic deviations are frequently present: low voltage, disturbances in rhythm and spread of the excitation current, and evidence of right heart strain.

Digestive Tract: The alimentary tract is commonly involved in scleroderma. The changes in the esophagus, which occur in about half of the cases and also often as the first visceral manifestation, are well known. Histologically, the gastrointestinal tract presents a fibrosis of the wall, with degeneration of the muscle fibers. The roentgen examination demonstrates a widening of the esophagus, which is changed to a wide rigid air-containing tube that transmits the cardiac pulsations with abnormal vigor. The descent of the barium through the esophagus with the patient upright is characteristic. Esophageal peristalsis is weakened or completely absent. Just above the diaphragm a narrowing of the lumen may be found, which is not relieved by anti-spasmodics. The cardia is often inadequate, allowing reflux, with peptic esophagitis and ulcer. Some patients also present a sliding hiatal hernia. The wall of the stomach is rigid, with poor peristalsis. The picture may suggest a linitis plastica. In the small intestine, one may see dilated segments, especially in the distal duodenum and jejunum, with accumulation of barium. Dilated sac-like segments are also seen in the large intestine, especially in the transverse and descending segments. Passage through the alimentary canal is considerably delayed, even to fifteen hours.

Soft-tissue calcifications are found especially in the finger pads and on the flexor aspects of the phalanges and in the periarticular tissue. The calcium nodules are often palpable through the skin and may even drain externally. Calcification may also be found in the soft parts of the pelvis, the annulus fibrosus of the heart, and in the capsule of the liver and spleen.

Teeth: In about 10 per cent of the cases a widening of the periodontal membrane as a result of the thickening of the collagen fibers can be found. The molars and premolars are especially involved. The lamina dura is intact.

Skeleton: Scleroderma may be manifest in the skeleton by a general osteoporosis, and especially by osteolytic defects in the distal phalanges of the fingers and even in the toes, bilateral and symmetrical. In advanced cases flexion contractures appear, as well as defects in the remaining phalanges and even in the metacarpals. While sclerosis in the shafts of the fingers has been reported, resorption in the distal portions of the end phalanges is more characteristic.

Associated with symptoms referable to the joints, radiologic changes may be found, notably, narrowing of the joint "space" with partial fusion.

Changes in the *blood vessels* can be demonstrated angiographically.

Twelve roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Ochronosis: Report of a Case. Alexander M. Minno and James A. Rogers. Ann. Int. Med. **46:** 179–183, January 1957. (A. M. M., Lahey Clinic, 605 Commonwealth Ave., Boston 15, Mass.)

Ochronosis is an extremely rare disorder but, when present, is quite disabling. Alkaptonuria may exist for many years before the signs and symptoms of ochronosis become pronounced. If alkaptonuria is detected early, the onset of the so-called alkaptonuric osteoarthritis may be delayed.

A case of alkaptonuria in a 38-year-old white man with secondary ochronosis is reported, in which symptoms had been present for at least ten years. Because of his occupation as a chef, this patient had been consuming excessive amounts of protein. The characteristic features of ochronosis had been evident for a long time. They included (1) dark staining of underclothing from urine and perspiration, (2) diabetes mellitus, which had been diagnosed in the past, (3) bluish discoloration of cartilages of the ears and pigmentation of the sclerae, (4) presence of urinary homogentisic acid, and (5) typical roentgen findings, including narrowing of all the intervertebral disks and sclerotic changes on opposing surfaces of adjacent vertebrae, with disk calcification and minimal hypertrophic changes.

This patient was treated with high doses of ascorbic acid (1,000 mg. daily), a low-protein diet, acetylsalicylic acid in doses adequate to insure comfort (10 to 50 gm. daily), heat and rest. On this program he experienced a sense of well-being and a general reduction of all previous symptoms. Just which portion of this program was directly responsible for the patient's improvement could not be determined.

Two roentgenograms. STEPHEN N. TAGER, M.D.
Evansville, Ind.

Fatal Air Embolism During Presacral Insufflation of Air. Aaron M. Lefkovits. J. Urol. **77**: 112–115, January 1957. (VA Medical Teaching Group, Kennedy Hospital, Memphis 15, Tenn.)

The author reports a fatality following the presacral insufflation of air. The patient was a 47-year-old diabetic with arteriosclerosis and fluctuating hypertension. The regitine test was positive for pheochromocytoma. At autopsy, air was found in the retroperitoneal tissues in the region of the kidneys, in the coronary vessels, and in the right ventricle. The cause of the air embolism could not be determined as air had been introduced into the retrorectal space which is allegedly avascular. Presacral air insufflation had been performed at the author's hospital in 14 cases prior to this fatality. Complications included pain in the epigastrium, dull aching retrosternal pain, abdominal discomfort, pain in the left side of the abdomen, pain in the shoulders on deep inspiration, subcutaneous emphysema of the abdomen, external genitals, neck, mediastinum and free air under the diaphragm. All of these complaints were of brief duration and disappeared spontaneously in a few hours to several days.

One roentgenogram; 1 table. ASMINO, M.D.
University of Pennsylvania

RADIOTHERAPY

Early Reports on Roentgen Therapy Combined with Local Application of Oxygen in the Treatment of Skin Tumors. Hermann von Saal and Wilhelm Albrecht Dalicho. Strahlentherapie **102**: 31–42, January 1957. (In German) (Röntgen- und Strahleninstitut der Stadt Gera, Gera, Germany)

In the treatment of malignant tumors of the skin several observations speak in favor of local application of oxygen just prior to x-ray therapy. The authors give a historical review of the influence of oxygen on malignant tumors starting with Warburg's theory on the possibility of malignant transformation of a normal cell when its respiration is impaired.

Experiments revealed an increased radioresistance in irradiated animals when the oxygen supply was decreased. On the other hand, increased oxygen supply was associated with increased radiosensitivity. The authors, therefore, tried to increase the amount of oxygen at the tumor and its surrounding area by two methods: (1) a local oxygen spray and (2) local insufflation with 20 to 60 c.c. of oxygen, so that the tumor is surrounded by an air cushion. The oxygen application was carried out immediately before the x-ray treatment. The local oxygen insufflation appeared superior to the spray technic.

Contact therapy (Chaoul) at 60 kv, 4 ma, 3 to 5 cm. focal skin distance was used in 32 patients with malignant skin tumors for the evaluation of the combined method. A control series of 112 skin tumors were treated without addition of oxygen. With the combined method, a saving of over 50 per cent of the total x-ray dosage was effected, an average of only 3,000 r being required as against 6,500 r with irradiation alone.

The authors offer this preliminary report in the hope that their findings will be tested on a larger scale to obtain further evaluation of this method.

Twelve photographs; 1 table, presenting details of the treated cases. HERBERT C. POLLACK, M.D.
Chicago, Ill.

Clinical Aspects and Therapy of Melanoma. Guido Miescher. Strahlentherapie **102**: 1–20, January 1957. (In German) (Dermatologische Universitätsklinik Zürich, Zurich, Switzerland)

The difference of opinion concerning the pathogenesis and therapy of malignant melanomas is so pronounced among dermatologists, radiologists, and surgeons that a clarification of these problems is of the utmost importance to those physicians who are entrusted with the treatment of this disease. As soon as the diagnosis has been established, the fate of the patient depends on the type of medical management, which determines life or death.

The author first discusses the surgical methods, including electrocoagulation, which has the advantage of tissue fixation, thereby preventing mobilization or implantation of live tumor cells. The coagulated tissue is removed by electrocautery in a second procedure. This method, however, often requires cosmetic transplantations.

Lately, electrocoagulation has been abandoned in favor of radical surgery striving for complete removal of the entire tumor with a wide skin margin and including extensive block dissection. If the tumor is located in an extremity, amputation of the entire extremity has been advised.

The results of radiation treatment have considerably improved with the introduction of fractional x-ray therapy and especially with contact therapy (Chaoul), establishing the fact that these modalities deserve an important place in the management of this condition. The author believes that for a primary tumor, without clinical metastasis, surgery might be preferable, although equally good results are seen following irradiation. In his opinion the best method of treatment consists of preoperative irradiation, to immobilize tumor cells, followed by surgery. The same procedure is used in the treatment of the primary tumor and of the metastases.

The location of the melanoma is of great significance, as those which are exposed to pressure or strain, such as the tumors on the feet and extremities, show a greater tendency toward metastasis.

No cures have been observed following treatment with radioactive isotopes or karyostatic remedies but temporary improvement has frequently occurred. Radioactive phosphorus, anti-rabies vaccine, and irradiation of the hypophysis have all been tried with palliative effect.

The treatment plan should be worked out by the radiologist together with the surgeon, and a constant contact between these specialists should be maintained.

The management of melanotic precancerous lesions, on the other hand, the author considers no problem at all. These cases can be easily handled with grenz-ray therapy: 2,000 r at 12 kv, with 1.0 mm. cellon filter, at intervals of three or four days for four or five treatments. The results are excellent, even from the cosmetic standpoint.

The author emphasizes that a considerable percentage of malignant melanomas are curable. Early adequate treatment before the appearance of metastasis is of the utmost importance. If the treatment is carried out in an appropriate and competent manner, neither the surgical nor the radiological method shows any superiority.

Two photomicrographs; 7 photographs; 9 tables.

HERBERT C. POLLACK, M.D.
Chicago, Ill.

A Contribution to the Therapy of Melanoma. A. Vonessen. Fortschr. a. d. Geb. d. Röntgenstrahlen **86:** 113–117, January 1957. (In German) (Strahlenabteilung der Städt. Krankenanstalten Kemperhof, Koblenz, Germany)

The author reports on 47 cases of pigmented tumors diagnosed as melanoma within an eight-year period. In 13 cases the diagnosis was established histologically; in 18 it was confirmed clinically by definite tumor growth with increase in pigmentation, chronic inflammation, or ulceration. Sixteen cases remained unproved.

When malignant melanomas are limited to the primary site, freedom from recurrence can be expected for a long time after either surgical or radiotherapeutic removal. In individual cases, combined therapy may be successful in the presence of a solitary lymph node metastasis. Since there is considerable danger of dissemination after surgical intervention, biopsy is not recommended. In 7 of 12 surgically treated patients lymph node metastases appeared after a few weeks.

Since the question of the evolution of the malignant from the benign variety is unsettled, and the benign nevi in general are radioresistant, neither surgery nor radiotherapy is recommended for these lesions.

The author comments on the extreme difficulty in the clinical diagnosis of malignant melanomas and their differentiation from pigmented keratomas, keloids, basal-cell tumors, seborrheic warts, sclerosing angiomas, and even inflamed accessory nipples. He advises close cooperation of the radiologist and dermatologist, with their respective skills and facilities.

Two tables.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Roentgen Therapy in Cushing's Syndrome without Adrenocortical Tumor. F. C. Dohan, A. Raventos, N. Boucot, and E. Rose. J. Clin. Endocrinol. **17:** 8–32, January 1957. (School of Medicine, University of Pennsylvania, Philadelphia, Penna.)

The authors present the results of irradiation of the pituitary in 12 cases of Cushing's syndrome without detected adrenocortical tumor and analyze the possible reasons for variation in effectiveness of roentgen therapy in these and adequately documented cases noted in a partial review of the literature.

In general, radiation was delivered to the pituitary region through multiple cross-firing portals, large enough to encompass the hypothalamus as well as the pituitary. In addition to recording the total dose achieved and the total length of the treatment period, the authors also calculated the "tissue roentgens per day," which they conceive as the *average daily dose*, by dividing the total depth dose by the total number of days over which the course of therapy extended.

In 5 of the 12 cases in the authors' series, results were classified as excellent, in 2 fair, and in 5 poor. These results are based on the effects following the first course of radiation therapy; in 1 of the cases classified as a poor result, after three courses of radiation failed, the effect of a fourth course of therapy was rated fair. In general, six months elapsed between the initial treatment and evidence of marked improvement in the 5 patients with excellent results; all 5, however, showed appreciable changes within three months. The authors note that the length of time required for the appearance of significant improvement following radiation therapy is considerably greater than the two to three months required for similar improvement following subtotal or total adrenalectomy. One patient who exhibited marked improvement following treatment (3,800 r depth dose over a period of thirty-four days) underwent a five-month period of hypophyseal insufficiency.

Five of the authors' 7 patients exhibiting a fair or poor response died (primarily of cerebral vascular accident); 1 could not be traced, and the other was living, with hypertension and other signs of adrenocortical hyperactivity.

The authors have analyzed their 12 cases, plus 12 sufficiently documented cases from the literature, for the relationship between the time-dose parameter and result. They found, by plotting these data according to the method of Strandqvist, that a line could be drawn which effectively separated those cases obtaining a good result from those in whom the result was equivocal or poor. They conclude that the line so obtained represents the minimum effective time-dose relationship for Cushing's syndrome, and that doses which fall above this line will have the best probability of resulting in improvement, provided the radiation tolerance of the brain stem is not exceeded. For the latter reasons, they have incorporated in their graph a line drawn after Boden, who studied the radiation tolerance of the brain stem. [The authors have labeled this line radiation tolerance of the central nervous system, though Boden's original study pertained primarily to the brain stem. Many therapists feel that the radiation tolerance of the cerebral cortex is higher than that of the brain stem or spinal cord.—J. E. B.]

Following their analysis further, the authors are convinced that careful studies are justified to test the hypothesis that Cushing's syndrome will respond to a relatively low total roentgen dose delivered at a high average daily increment, such as 1,000 r in five consecutive days or 1,500 tissue r in ten days. They cite Arnold's recent observations in monkeys (J. Clin.

Endocrinol. **14**: 859, 1954. Abst. in Radiology **64**: 912, 1955) which suggest that the therapeutic benefits following irradiation of the pituitary region are due to the effects on the hypothalamus rather than the pituitary, and therefore feel that size of the x-ray portals should be large enough to encompass the hypothalamus.

Seven figures; 3 tables. JAMES E. BAUER, M.D.
University of Missouri

Results of Treatment of Cancer of the Breast. T. A. Watson. Surg., Gynec. & Obst. **104**: 106–112, January 1957. (Saskatoon City Hospital, Saskatoon, Sask. Canada)

It has been demonstrated that 85 per cent of all cases of cancer occurring in the Province of Saskatchewan, Canada, are referred to one of the two free clinics operated by the Saskatchewan Cancer Commission. This results in a unique opportunity to study, in an unselected fashion, almost all of the cases of a particular type in that geographic area.

From 1932 to 1949, 1,664 patients with breast carcinoma were seen, with a crude five-year survival of 46.6 per cent. Those cases which had previously been treated elsewhere were then removed from the analysis and the remainder were further divided on the basis of treatment before and after 1944, in which year the treatment methods became less variable: 645 fell in the period 1932–1943, and 629 in the period 1944–1949.

In general, the treatment policy has been radical mastectomy followed by irradiation. Details of the surgery and the roentgen therapy factors are not stated. Before 1944, as suggested above, there were more variables in the type of treatment. For instance, for a time, x-ray or radium therapy exclusive of surgery was used in some cases. After 1944 the treatment policy of radical mastectomy followed by roentgen therapy was generally, but not invariably, followed. Some variations were permitted, apparently for comparison of statistics. For instance, in Stage I cases, where the lesion was confined to the breast without axillary metastases, 75 cases were treated by radical mastectomy alone with a 78.6 per cent five-year crude survival. This was compared to 96 cases of the same stage which received postoperative roentgen therapy and had a five-year crude survival rate of 78.1 per cent. The crude five-year survival rate for the 645 cases seen before 1944 was 39.1 per cent compared to 48.3 per cent for the 629 cases seen between 1944 and 1949.

It is claimed that this series of cases is similar to McWhirter's series from the point of view of selection and geographic distribution. McWhirter, working in southeastern Scotland, advocates simple mastectomy followed by postoperative roentgen therapy. In 1,882 cases seen between 1941 and 1947 (Brit. J. Radiol. **28**: 128, 1955), his five-year crude survival rate was 42 per cent compared to 48.3 per cent in the present series.

Although it is claimed by some authors that no treatment influences the course of mammary cancer, these statistics demonstrate the contrary.

One graph; 7 tables. MORTIMER R. CAMIEL, M.D
Brooklyn, N.Y.

The Results of Treatment of Ovarian Cancer with One Million Volt X-Ray. Florence C. H. Chu. Surg., Gynec. & Obst. **104**: 45–52, January 1957. (Memorial Center for Cancer and Allied Diseases, New York, N. Y.)

On the basis of the review of 112 patients treated in the Department of Radiation Therapy at Memorial Center and from the reports in the literature, the author believes that radiation has definite value in the management of ovarian carcinoma. In summarizing her observations she states: "Radiation has been considered an important adjunct to surgery, and even in advanced cases in which definitive surgery is not feasible radiation has given palliation, subjective or objective, with an average duration of about nine months in approximately two-thirds of the cases. The results of radiation obtained in this study would appear to indicate that a tumor dose of 3,000 to 5,000 roentgens in three to six weeks gives a better chance of response than a lower dosage. It is possible to deliver a higher midplane dose to large ports with supervoltage therapy than it is with conventional x-ray energies. The solid and the mixed solid and papillary types of serous adenocarcinoma are more malignant than the papillary type, but no significant difference in the responsiveness of any of the three subdivisions to irradiation was noted."

Seven tables.

Tumours of the Testicle. R. J. M. Whittle. Brit. J. Radiol. **30**: 7–12, January 1957. (St. Bartholomew's Hospital, London, E.C. 1, England)

In reporting a series of 143 testicular tumors, the author suggests that, because of their rarity, the clinician should maintain a critical attitude toward figures for survival rates, age incidence, and pathological distribution. His material was compiled between the years 1932 and 1951. In 135 cases simple orchiectomy represented the primary treatment; in 8 cases only radiotherapy was administered because of the extent of the disease.

Seminomas accounted for 79 cases (61 per cent) and teratomas for 50 cases (39 per cent) of the series. Fourteen cases were unclassified. The author feels that the marked difference in radiosensitivity between the seminoma and teratoma indicates that they are distinct tumors. The factors which institute neoplasia may give rise to either type, for in bilateral cases the tumors are often mixed, and rarely both occur in the same organ.

The peak incidence for teratoma was between twenty-five and thirty-four years, while that of seminoma was in the following decade. Five cases arose in childhood (under fourteen years), 4 of which were teratomas.

The most common presenting symptom was a painless progressive enlargement of the testis, observed in 65 per cent of the cases. Pain, when it occurred, was usually of a dragging, aching type. In a few cases there was a sudden attack of great severity accompanied by a rapid increase in size of the testicle.

Tumors appeared in undescended testicles in 10 cases, or 7 per cent. This corroborates the impression that an ectopic testicle is prone to be the seat of a neoplasm. Prognosis in these cases, however, depended upon the pathological findings and not the anatomical site. Breast hypertrophy was found in 10 cases, and in 4 per cent of the series the tumors were bilateral, with an interval of four to six years before development of the second tumor.

A simple staging was devised as follows: Stage I, disease restricted to the testicle; Stage II, metastases present in the abdomen; Stage III, extra-abdominal metastases.

The treatment fields should include the retroperitoneal nodes, but need not include the inguinal canal or

scrotum. The ipsilateral external iliac nodes require treatment, since in 7 cases recurrence in this area was noted.

In evaluation of results, a three-year survival rate is used, since there were only 4 fatalities due to the disease after this period. The technics used for postoperative prophylactic irradiation in the 200- to 250-kv range were the following: (1) Anterior, posterior and lateral fields to cover the lumbar nodes, and two opposing fields in the external iliac region on the side of involvement. The dose to the nodes was 2,000–2,500 r. Eighteen of 22 patients with seminomas survived with this method. (2) Opposing epigastric and ipsilateral pelvic fields, to deliver 2,000–2,500 r to the nodes. Twelve of 14 patients thus treated survived. (3) Two anterior and two posterior oblique fields directed at the nodes, achieving a dose of 3,000 r. All 10 patients thus treated survived.

Results in all stages of seminoma were more favorable than in corresponding stages of teratoma. Thus, seminomas of Stages I and II gave three-year survival rates of 87 per cent and 64 per cent respectively, while those for teratoma were 66 per cent and 12 per cent. Comparing these results with those of surgery alone, one notes that the survival rate has been doubled. When blood borne metastases to lungs were present, the prognosis became poor. Of 6 patients with seminoma with pulmonary metastases, only 1 survived; among 9 cases of teratoma there were no survivals.

The serious complications of roentgen therapy were few. They included pulmonary embolism, which usually occurred early, mesenteric thrombosis, and renal damage and sterility.

Three figures; 6 tables. JAMES F. NICHOLS, M.D.
Cleveland City Hospital

Treatment of Malignant Effusions. James A. Martin and Robert B. Connor. Texas State J. Med. **53:** 21–27, January 1957. (J. A. M., 3501 Gaston Ave., Dallas 26, Texas)

Report is made of a series of patients receiving palliative or prophylactic instillations of radioactive gold or phosphorus for malignant effusions. Of 52 gold injections, 41 were for palliative treatment of effusions secondary to metastatic cancer and 11 were for prophylactic purposes. Sixteen patients received radioactive phosphorus: 13 for malignant effusions and 3 for prophylaxis. Methods of administration and dosages utilized were similar to those in general usage. Nausea and/or vomiting were encountered in approximately 50 per cent of the patients receiving intraperitoneal gold but ordinarily these were readily controlled by appropriate medication. A few patients experienced transient fever subsiding spontaneously after one or two days. None of the patients exhibited severe marrow depression, although a few showed temporary blood count depressions. In a few there was an apparent local chemical irritation of the serous surfaces following injection of the isotope. In some cases pain was severe enough to require narcotics but generally subsided spontaneously in one or two days.

A "satisfactory result," *i.e.*, retardation or cessation of fluid, occurred in 29 of 54 administrations in 48 patients. Fifteen treatments were judged "unsatisfactory," and 10 were "indeterminate" in that the patient died a short time after treatment and possible benefits could not be assessed. The authors could determine no difference in effectiveness between gold and phosphorus but note that phosphorus is considerably easier to handle from the radiation standpoint. Nor was any relation observed between the tumor type and response, except that metastatic breast lesions tended to show poorer results.

Of 11 patients treated prophylactically following surgical removal of ovarian carcinoma, 9 were alive and well after four months to two years. Two patients had early recurrence and died within six months.

The author makes a plea for more careful selection of patients for this mode of therapy. Moribund individuals and those in very poor condition should not be so treated, nor should those who have extensive metastatic disease elsewhere. There appears to be definite indication for prophylactic intracavitary use of radioactive gold and radiophosphorus following removal of primary tumors, particularly ovarian carcinomata.

Two short case histories are included.

Three roentgenograms; 5 photomicrographs; 2 tables.
JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Lymphosarcoma. A Study of Five Year Survivals with X-Ray Therapy. Dean Nichols, Charles Phillips, and Arno W. Sommer. Texas State J. Med. **53:** 28–34, January 1957. (A. W. S., 213 W. Avenue G, Temple, Texas)

One hundred one cases of the various forms of lymphosarcoma managed solely by roentgen therapy and followed for five or more years are analyzed. Each case was classified as to histologic type and clinical stage at the time of institution of treatment. The report is primarily a statistical one, with a moderately detailed summary of survival results in each of the multiple categories. Conclusions include the following points: Clinical staging is a much more reliable prognostic basis than is histologic grading on the Broders system. As is to be expected, those patients with disease of clinical Stage I (one area only invoved) have the best prognosis, and survival rates fall as clinical staging increases. Histologic grading has some useful purpose in that lower grades present higher survival rates than the more anaplastic tumor types. Such grading, however, did not hold for Hodgkin's disease, in which the authors felt that an actual reversal of this trend was shown by their series. The type of lymphosarcoma is also felt to be of prognostic significance. Hodgkin's disease generally has the best prognosis, while reticulum-cell or stem-cell types have the poorest. Tumors showing admixtures of types tend to have poor survival rates.

A study of life expectancy tables for the population at large as compared with patients with lymphosarcoma reveals an interesting point: a patient with lymphosarcoma developing around the age of fifty years who survives for six years after roentgen therapy may look forward to a normal life expectancy.

Roentgen therapy was administered with conventional voltage technic. The dosage schedule utilized was very conservative. Stage I cases received tumor doses in the 2,000 r range in fourteen days. Stage II lesions (two consecutive lymph node groups involved) received 2,000 r tumor dose in twenty-one days. Stage III cases (generalized or scattered lesions) received tumor doses of approximately 570 r in two days to superficial nodes and 1,100 r tumor dose in ten days to deep-seated lesions. Additional therapy courses were given as needed.

Comparison with survival reports from other large

series shows a favorable statistical result for the currently recorded group. The authors note that a comparison of survival rates by clinical stages is a much more accurate method for assessing results than the comparison of gross survival rates.

Three charts; 12 tables. JAMES W. BARBER, M.D. Cheyenne, Wyo.

Radiotherapy in Arthritic Conditions. G. D. Kersley. J. Fac. Radiologists **8:** 181–186, January 1957. (Royal National Hospital for Rheumatic Diseases, Bath, England)

A series of 788 cases of arthritis of different types is reviewed, with particular attention to their response to x-ray therapy for relief of symptoms.

The cases were grouped as osteoarthritis, rheumatoid arthritis, ankylosing spondylitis, and spondylitis with involvement of peripheral joints. X-ray therapy was given at high voltage (220 kvp) and at low voltage (140 kvp), with doses ranging from 300 to 2,000 r in four to six weeks. Treatments were administered to the spine and sacroiliac regions, and to symptomatic joints as indicated. The high-voltage group usually received 300 skin r per field, per week, for four to six weeks. The low-voltage treatments were given at a rate of 50 skin r twice weekly per field to a total dose of 300 skin r.

In all but the rheumatoid arthritis group response to the larger doses was significantly better than to the lower doses. Over half of 102 patients with osteoarthritis receiving adequate dosage (1,500 to 2,000 r) were improved, most of them markedly so. Of these, about 80 per cent maintained their improvement during a years observation. Response in the dorsal spine was usually better than elsewhere in the spine.

Results in the rheumatoid arthritis group were disappointing. There were 257 cases and response to treatment did not seem significant.

In 102 patients with ankylosing spondylitis, improvement was somewhat dramatic and was well maintained. Of 19 patients receiving high-voltage therapy in high dosage, 95 per cent were improved; with medium dosage, 88 per cent of 17 patients improved.

In all patients adjunctive measures such as physiotherapy, hydrotherapy, and general medical attention were administered as indicated during the period of radiotherapy. It did not seem to the author that the natural evolution of arthritis was changed by the radiation therapy. However, the pain ease and improvement in general well-being were of great help in rehabilitation of the patients.

Six tables. DON E. MATTHIESEN, M.D. Phoenix, Ariz.

Radiotherapy of the Rheumatic Diseases. Results of X-Ray Treatment of Ankylosing Spondylitis. Robert Morrison. J. Fac. Radiologists **8:** 187–192, January 1957. (M. R. C. Radiotherapeutic Research Unit, Hammersmith Hospital, London, England)

The author presents the late results (after several years) of roentgen therapy in ankylosing spondylitis. Of 122 patients who received irradiation more than three years earlier, 49 per cent required more than one course of therapy; 51 per cent were given a single course. In all cases the entire spine and sacroiliac regions were treated with 1,000 to 1,500 surface r in three weeks, and practically all reported early relief of symptoms.

In 25 per cent the disease progressed after treatment, and this tendency appeared greater in those who were in the more advanced stages of the disease when first treated. In 25 per cent, also, the disease clinically seemed still active at the time of the last examination. Eighty per cent of the patients were able to work and to earn a living, while 72 per cent were able to work normally.

There was poor correlation between the apparent clinical state of the disease and the sedimentation rate, especially when the disease was thought to be inactive.

In discussing the complications of treatment, the authors point out that the incidence of late leukemia is about 10 times that expected in patients not subjected to radiation.

Results reported by others are cited.

Two graphs; 5 tables. DON E. MATTHIESEN, M.D. Phoenix, Ariz.

Ankylosing Spondylitis. Its Hormonal Background in Relation to X-Ray Therapy. Basil A. Stoll. J. Fac. Radiologists **8:** 201–214, January 1957. (Peter MacCallum Clinic, Melbourne, Australia)

Because ankylosing spondylitis is predominantly a disease of young men, a relationship to hormone dysfunction has been surmised. Its response to cortisone suggests that it may belong to the group of "stress" diseases. In addition, the symptom-relieving properties of x-ray treatment in the disease have been ascribed to stimulation of the adrenal cortex. For these and other reasons, the author has made a rather complete review of the possible hormonal mechanisms which may be at work. He includes a review of the courses of 18 patients with ankylosing spondylitis in whom x-ray therapy was directed to the adrenal glands.

It is pointed out that, although irradiation technics and doses have varied rather widely in previous series, results have been remarkably uniform. In the cases which the author treated by irradiation of the adrenals, good relief of symptoms was obtained, and the method is advocated as being unlikely to cause ovarian or bone marrow changes.

Following irradiation, there is an increase in activity of the adrenal cortex, which may be seen even when the adrenal gland is not in the field of irradiation. How the effect is mediated is uncertain. It may be through liberation of a histamine-like decomposition product which causes increased secretion of ACTH by the pituitary.

One graph; 6 tables. DON E. MATTHIESEN, M.D. Phoenix, Ariz.

Roentgen Treatment of Myeloma with Special Consideration to the Dosage. Torsten Norin. Acta radiol. **47:** 46–54, January 1957. (King Gustav V Jubilee Clinic, Gothenburg, Sweden)

The author, in surveying the literature, has found only very sparse information as to the doses required to heal the tumorous tissue in myeloma. His own material consists of 30 cases of myeloma treated between 1943 and 1953, all verified patho-anatomically or by sternal puncture. Roentgen treatment was given in all cases to one or several areas, the factors being 170 to 200 kv, 10 to 15 ma, and 0.5 mm. copper plus 1.0 mm. aluminum filtration. The irradiated areas ranged between 50 and 250 sq. cm.; the daily dose was, as a rule, 300 to 400 r measured on the skin.

Strandqvist (Acta radiol. supp. 55, 1944. Reviewed in Radiology **46:** 526, 1946), in carcinoma of the skin and

lip, demonstrated a correlation between the results of treatment and dosage if consideration were given to both dosage and to duration of treatment. The author has handled his data similarly and, on log-log paper, has plotted points representing each of the tumors irradiated, coded as to whether the result was objective improvement or no objective improvement. Plotted also is a line representing Strandqvist's findings on healing of carcinoma of the skin. In general, the author found that cases showing no objective improvement were grouped below those cases which showed objective improvement, in so far as dosage was concerned. The line of division between these two groups was found to represent a cumulative roentgen dose of approximately 1,500 r as compared to the 2,200 r dose found by Strandqvist as the median dose necessary to obtain healing of carcinoma of the skin without skin necrosis. The author feels, therefore, that myeloma should thus be regarded as having a moderate radiosensitivity.

It is of considerable interest that the author was able to demonstrate, according to the method of Strandqvist, a more or less linear relationship between tumor response and the time-dose parameter.

Four roentgenograms; 1 diagram; 2 tables.

JAMES E. BAUER, M.D.
University of Missouri

Observations on the Value of Gastric Irradiation in the Treatment of Duodenal Ulcer. Erwin Levin, Charles B. Clayman, Walter L. Palmer, and Joseph B. Kirsner. Gastroenterology **32:** 42–49, January 1957. (W. L. P., 950 E. 59th St., Chicago 37, Ill.)

The authors analyzed the results in 723 patients with duodenal ulcer treated with irradiation to the stomach and observed for five to eighteen years. All patients had active duodenal ulcer. The patients constituted a selected group in two respects. First, surgery was not considered imperative; second, the symptoms were sufficiently severe to warrant hospitalization for approximately two weeks. Some intractable and some mild cases were automatically eliminated by these criteria. The series includes a larger number of difficult therapeutic problems than would have been present in an ambulatory group. The accepted routines of medical therapy were used in addition to irradiation.

Five different technics of irradiation were employed successively over the eighteen-year period. The patients treated prior to 1939 received amounts varying from 600 to 3,600 r (air); between 1939 and 1944 the depth dose to the fundus and body of the stomach ranged from 1,100 to 1,500 r; after 1944 the depth dose was 1,600 to 1,700 r given in ten to fourteen days. From 1948 to the present, the position of the stomach has been routinely delineated on the skin under fluoroscopic control.

Of the 723 patients treated in the period 1937 to 1950 inclusive and followed to January 1956, 332 (46 per cent) had recurrences. The interval between treatment and recurrence was less than twelve months in 126 patients. One hundred fifteen (16 per cent) of the entire series ultimately required surgery. The recurrence rate as computed "per 100 patient years" decreased from 102 before therapy to 17 after therapy, a reduction of 83 per cent. The severity of the recurrent symptoms was definitely ameliorated. Eight patients (1 per cent) died from ulcer, 4 from hemorrhage, 3 from acute perforation, and 1 from myocardial infarction following surgery for ulcer.

The reduction in gastric acidity produced by irradiation is variable and unpredictable. Two to four weeks following irradiation, gastric secretion decreased by over 50 per cent in 258 patients (36 per cent). This persisted for six to twelve months in 123 patients and one to eighteen years in 135. Histamine achlorhydria developed in 85 patients (12 per cent). The achlorhydria was transient and recurrences invariably were preceded by return of acid secretions to previous levels.

No significant lesion definitely attributable to radiation over the area was encountered in this group of patients. The significance of six known deaths from carcinoma of the stomach, pancreas, and duodenum developing two to thirteen years after treatment is yet to be determined.

The authors conclude that roentgen irradiation in moderate amounts to the acid-secreting areas of the stomach constitutes a safe and valuable adjunct in the treatment of duodenal ulcer.

Seven tables.

JOHN P. FOTOPOULOS, M.D.
Hartford, Conn.

Experiences with the 31-MEV Betatron and Its Further Development to the Asklepitron. H. R. Schinz. Fortschr. a. d. Geb. d. Röntgenstrahlen **86:** 104–113, January 1957. (In German) (Univ.-Röntg.-Inst., Kantonsspital, Zurich, Switzerland)

The depth-dose curves of 31-MEV betatron x-rays, 30-MEV electrons, cobalt 60 gamma rays, and 200-kv x-rays are compared. At a depth of 10 cm., the ratio between 200-kv, cobalt 60, and betatron rays is 1 : 1.48 : 2.4. It is evident that the advantage of the betatron over cobalt, in respect to depth dose, is greater than the advantage of cobalt over 200 kv.

With conventional radiation, bone tissue absorbs about two and one-half times as much as the soft parts. With cobalt and with 31-MEV rays the absorption in bone and the soft parts is about equal. The dose, therefore, is much more homogeneously distributed in the irradiated volume, without overdosage in bone in comparison with the soft tissues.

The author next considers the differential ion concentration, energy loss, etc., for the different rays. Irradiation with the conventional rays, cobalt or radium, and the van-de-Graaff apparatus is a continuous process, while that with the betatron is discontinuous (*Röntgenblitzes*). There are 50 *Röntgenblitzes* in one second.

Dosimetry with the betatron rays is not completely worked out. For example, it is not known whether the conditions of saturation in the ionization chamber are always fulfilled. Further, the ionization was measured in water rather than in air.

The biological effects of these different forms of radiation are qualitatively similar, but show some quantitative differences.

The older 31-MEV betatron has been slightly modified, producing the "asklepitron," which affords easier positioning of the patient and accurate aiming of the beam, permits rotation therapy, and may be used optionally for roentgen rays or electrons.

Thirteen figures.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

Modification of the Depth Dose Curves of Various Radiations by Interposed Bone. Lewis L. Haas and Glen H. Sandberg. Brit. J. Radiol. **30:** 19–26, January

1957. (Department of Radiology, College of Medicine, University of Illinois, Chicago, Ill.)

By means of a water phantom which is irradiated through a Lucite window, the authors investigated the influence of interposed bone of 0.5 and 1.0 cm. thickness on the penetration and absorption of x-rays generated at voltages ranging from 50 kv to 22.5 MEV and for electron beams at 13.1 and 17.8 MEV.

It was found that presence of bone did not alter the half-value layer characteristics of radiation in the 175- to 400-kv range, but that radiation in the 50- to 100-kv range was hardened with increasing depth, the traversed layers of bone or water acting not only as absorbers but also as filters in increasing the half-value layer. Therefore, though a simple percentage reduction in depth dose was found to hold for a specific thickness of interposed bone in the 175- to 400-kv range, the corrections necessary for calculation of depth dose data when radiation from 50 to 100 kv is utilized are not simple and were found to vary with depth.

With 22-MEV betatron x-rays the authors did not find a significant difference in dose rate in the depth due to bone absorption. However, there were pronounced interesting differences near the bone, it having been found that soft tissues in contact with bone, especially behind it, receive a higher dose than shown by standard curves. For the high-energy electron beam of the betatron the effect observed was a simple decrease of penetration. The necessary correction was determined to be a shortening of the depth-dose curve at the site of the bone varying between 3 and 6 mm. behind 0.5 and 1.0 cm. thick bones at 13.1 and 17.8 MEV energies.

For x-rays of 175 to 400 kvp, the correction in depth dose values for interposed bone was found by the authors to be a simple and uniform percentage reduction over the entire depth dose curve. The percentage reduction was found to vary between 3 and 22 per cent at different energies.

Sixteen figures; 3 tables. JAMES E. BAUER, M.D.
University of Missouri

RADIOISOTOPES

Thyroid Function Studies in Children: Normal Values for Thyroidal I^{131} Uptake and PBI^{131} Levels up to the Age of 18. Leo Oliner, Robert M. Kohlenbrener, Theodore Fields, and Ralph H. Kunstadter, with the technical assistance of Dolores R. Goldstein. J. Clin. Endocrinol. **17**: 61–75, January 1957. (Michael Reese Hospital, Chicago, Ill.)

The authors have undertaken to establish normal standards for thyroidal uptake and serum PBI^{131} values at various ages in children and to clarify the discrepancies in normal uptake values reported from various parts of the United States. Eighty-three children were selected ranging in age from two and a half months to eighteen years; 61 were considered normal so far as thyroidal status was concerned and 12 had various thyroid disorders. Ten were tested but were not included in the study, usually because of having been given various substances which affect thyroid function.

Thyroid uptake data were obtained by scintillation counting and were expressed as a percentage of the administered dose corrected for decay. The PBI^{131} determinations were made according to the simplified procedure outlined by Fields and Kaplan (J. Lab. & Clin. Med. **43**: 960, 1954). Both thyroidal I^{131} uptake and serum PBI^{131} determinations were made at twenty-four and forty-eight hours following administration of the dose.

The tracer doses given to young children were about 25 microcuries; those above ten years of age were given 50 microcuries. Calculations using standard formulas, assuming an adult biologic half-life of the element in the body, suggest that the gland of a normal child would receive about 90 equivalent roentgens per gram of tissue. The authors point out that this amount of radiation is much below the level at which a possible association between external x-radiation of the neck and upper chest and the production of thyroid carcinoma has been intimated, and state that, in addition, since 1939 no carcinogenic effect due to radioiodine has thus far been reported in adults receiving up to 50,000 equivalent roentgens per gram of tissue in the treatment of hyperthyroidism and of euthyroid cardiac patients.

Thyroidal twenty-four- and forty-eight-hour I^{131} uptake values for the normal group of children were within the normal adult range and were not affected by body weight or sex. Up to the age of four years, PBI^{131} values at twenty-four and forty-eight hours were significantly elevated as compared with the adult. Although the values in the five- to nine-year group were within the normal adult range, the mean value was significantly elevated. It is felt that the PBI^{131} data may indicate a state of "hyperactivity" of the thyroid gland in children up to the age of four years and possibly longer when compared with the euthyroid adult.

The authors discuss reports in the literature concerning the normal thyroidal I^{131} uptakes in children from various parts of the country and suggest that the differences in the reported values may be due to such factors as the radiochemical purity of the radioiodine administered and, too, the intake of cod liver oil.

Three figures; 5 tables. JAMES E. BAUER, M.D.
University of Missouri

Effects of an Organic Iodine Compound (Priodax) on Tests of Thyroid Function. D. Ward Slingerland. J. Clin. Endocrinol. **17**: 82–93, January 1957. (Tufts University School of Medicine, Boston, Mass.)

The author presents a study of the effects on tests of thyroid function of the administration of organic iodine compounds in animals and in human beings. The organic iodine compound used in most of the studies was iodoalphionic acid (Priodax), though some studies were carried out following the administration of Telepaque and inorganic iodide.

The half-life of radioactive Priodax in the rat and guinea-pig was as short as five hours for the first day, and thereafter was about two to four days. Deiodination seems to occur to a significant extent in these animals, and high levels of inorganic iodide may block the thyroid, thus permitting more rapid excretion by the kidneys. The major urinary excretory product is, however, Priodax glucuronide. In man, deiodination seems to occur to a minimal extent, and the short half-life observed (twelve hours) seems to be based on the rapid urinary excretion, mainly of Priodax glucuronide.

It was found, in human subjects, that administration of Priodax, Telepaque, or Cholografin was followed by depression of the thyroidal I^{131} uptakes and extreme

elevation of the PBI level. The PBI levels were maintained at high values and descended rather slowly over a period of a few months. The thyroidal I^{131} uptake values returned to normal at a rate which appeared more or less proportional to the rate of activity of the thyroid, *i.e.*, the restoration of previous levels was more rapid (a week or ten days) in hyperthyroid patients than in euthyroid patients (approximately four weeks). There were some cases in which depression of thyroidal I^{131} uptake values persisted for several months, and the author mentions a report of the development of myxedema following administration of organic iodine.

Six chromatograms; 7 charts; 2 tables.

JAMES E. BAUER, M.D.
University of Missouri

Influence of Iodoalphionic Acid (Priodax), With and Without Thyrotropin, on Thyroidal I^{131} Uptake in Euthyroid Patients. Stanley Newman and Claude M. Cupp. J. Clin. Endocrinol. **17:** 94–98, January 1957. (The Isotope Clinic and Department of Medicine, Letterman Army Hospital, San Francisco, Calif.)

The authors state that the inhibiting effect of Priodax on the thyroidal uptake of radioactive iodine is, in their experience, of shorter duration than some reports in the literature would indicate. They therefore undertook to determine more accurately the length of the period during which thyroidal I^{131} uptake is diminished after the ingestion of this compound.

Studies were made on 11 clinically euthyroid subjects having initial base line 24-hour thyroidal I^{131} uptakes within the euthyroid range of 15 to 40 per cent. The uptakes were reduced to less than 10 per cent in all patients during the first week after the administration of Priodax (six 0.5-gm. tablets). In studies on 5 of the 11 subjects, the administration of a single 5-unit intramuscular dose of TSH (thyrotropin) was in all cases but 1 followed by an uptake twenty-four hours later which was within the euthyroid range. In this 1 case there was no response to TSH at six days but the patient subsequently responded much as did the others.

Uptakes determined one week after a dose of TSH no longer demonstrated any residual effect. This is in agreement with the report that the effect of TSH lasts for three to four days. TSH was effective in temporarily abolishing the depression of I^{131} uptake caused by Priodax, but it had no lasting effect in shortening the period of suppression.

The authors conclude that the administration of Priodax supresses the thyroidal uptake of radioactive iodine for less than thirty days in euthyroid subjects, and that thyroidal uptakes determined beyond thirty days after the use of Priodax for cholecystography should be reliable in most cases. In thyroid function tests at a shorter interval after administration of Priodax, the administration of thyrotropin is of value in temporarily overcoming the suppressive effect of the medium. Eventually, the I^{131} uptake rises spontaneously to the euthyroid level, regardless of whether or not thyrotropin has been administered.

Two figures.

JAMES E. BAUER, M.D.
University of Missouri

Management of Carcinoma of the Thyroid. Robert E. Mack, Hershel J. Wells, and Richard E. Ogborn. J.A.M.A. **163:** 15–20, Jan. 5, 1957. (R. E. M., 915 N. Grand Blvd., St. Louis 6, Mo.)

The authors discuss the treatment of carcinoma of the thyroid as it is carried out at Walter Reed Army Medical Center. All accessible thyroid tissue, both normal and pathological, is removed surgically, usually by total thyroidectomy. Radical neck dissection is performed when indicated. Several weeks after surgery, studies are made with I^{131} in an attempt to locate any residual functioning thyroid tissue. These latter studies include determination of the twenty-four-hour thyroidal uptake, of the ninety-six-hour urinary excretion of I^{131}, manual scanning of the body with a directional scintillation counter for evidence of extra-thyroidal I^{131} concentrations, and the recording of a scintigram of the neck region. Three cases are reported in detail to illustrate the procedure followed. One of the patients exhibited a severe reaction following the use of thyroid-stimulating hormone. In view of this and a similar reaction in another case, the authors now restrict the use of this hormone to the preparation of patients with carcinoma of the thyroid for therapy with I^{131}.

The authors state that, in utilizing this program of follow-up investigation with radioactive iodine, unexpected metastatic lesions have been discovered and therapy instituted when no evidence of metastatic disease was apparent by other methods of examination. Although the patients in the reported cases were all suitable for therapy with I^{131}, surgery is regarded as the treatment of choice for both the primary tumor and the metastatic lesion whenever it can be safely carried out.

Nine figures are presented, showing the microscopic picture and I^{131} scintigrams obtained in the 3 cases reported.

JAMES E. BAUER, M.D.
University of Missouri

Myxedema Induced by Prolonged Iodide Administration. Herbert M. Rubinstein and Leo Oliner. New England J. Med. **256:** 47–52, Jan. 10, 1957. (L. O., Michael Reese Hospital, Chicago, Ill.)

A case of myxedema following prolonged iodine ingestion is reported. A 33-year-old white woman with a history of hay fever and asthma since early childhood had been taking patent medicines without prescription over a period of years. Analysis of the drugs and the patient's dosage schedule indicated she was receiving in the range of 244 mg. of iodide daily, taken mainly for relatively intractable bronchial asthma. Initial symptoms of thyroid dysfunction began about four years before admission, with slight enlargement of the gland, puffiness of the eyelids, skin, and neck, and changes in the hair. A full blown and classical appearance of myxedema had developed by the time of the patient's hospitalization. Physical and laboratory findings are reported at length. Radioiodine uptake studies performed a few days after all iodine medication had been discontinued showed a rapid concentration of iodine in the gland reaching 70 per cent at two hours, with subsequent rapid discharge into the blood stream. The curve was interpreted as showing that the iodine-trapping mechanism of the thyroid gland was functioning normally but that the iodine was not transformed into organically bound form. A second uptake study done one week after the first, and more than ten days after the last oral intake of inorganic iodine, showed an entirely different functional state of the gland. At this test virtually all of the administered I^{131} was accumulated in the gland and avidly retained there. A dose of potassium thiocyanate at six hours did not result in discharge of I^{131} from the gland, suggesting that the radioiodine in the thyroid was organically bound.

The authors theorize as to the explanation of these phenomena, with references to the available literature. They conclude that myxedema resulting from prolonged ingestion of iodide is caused primarily by block of thyroid hormone synthesis due to a persistent elevation of the serum iodide level. Evidence is cited to show that excessively high plasma iodide levels will result in inhibition of binding of iodine even though the iodine-concentrating mechanism of the gland is functioning well.

Two photomicrographs; 2 charts; 2 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

The Thyroid Hormone-Plasma Protein Complex in Man. II. A New *in Vitro* Method for Study of "Uptake" of Labelled Hormonal Components by Human Erythrocytes. Milton W. Hamolsky, Myron Stein, and A. Stone Freedberg. J. Clin. Endocrinol. **17**: 33–44, January 1957. (Department of Medicine of Harvard Medical School, Boston, Mass.)

The authors present a new method for study of the *in vitro* incorporation of thyroid hormonal components by human erythrocytes, summarize results of its use in a variety of clinical conditions, and evaluate its possible contribution to our knowledge of thyroid function.

The thyroid hormone component selected for study was I^{131}-labeled *l*-triiodothyronine (I^{131}-TRI), which was made up in isotonic saline to contain from 10–120 × 10− 4 micrograms per 0.1 milliliter. This solution was mixed and agitated with whole blood from the patient and incubated at 37°C. for varying periods of time. Following incubation, radioactivity in these samples was determined by use of a well-type scintillation counter, and following centrifugation of the specimen, the activity of the saline-washed erythrocytes or of the supernatant plasma was measured. The percentile erythrocyte "uptake" was then calculated as the ratio of cell-bound activity per milliliter of whole blood. Four determinations were performed for each patient and the uptake expressed as an average of the results.

In a series of "criss-cross" experiments, plasma from one donor was combined with the erythrocytes (washed or unwashed) from another compatible donor with the same or different thyroid status, and the erythrocyte uptake in this reconstituted blood was then similarly determined; 59 such experiments were performed. In 56 studies, the erythrocyte uptake was determined by the thyroidal status of the plasma donor, *i.e.*, the uptake of hyperthyroid erythrocytes in euthyroid plasma was in the euthyroid range, and *vice versa*.

There was found to be a rather good separation of erythrocyte uptake values as correlated with the clinical thyroid status. In 96.2 per cent of the euthyroid subjects, the erythrocyte uptake was below 16 per cent, while in 95.5 per cent of the hyperthyroid patients the uptake exceeded 17 per cent. At the other end of the spectrum, only 2.6 per cent of euthyroid subjects had uptakes between 10 and 11 per cent, whereas 74.2 per cent of hypothyroid patients had values of less than 10 per cent.

The effects of sex, age, season, and therapy for hyperthyroidism were studied. Following administration of non-thyroid organic iodine-containing compounds there was either no change or slight increase in uptake. The erythrocyte uptake was strikingly decreased in pregnancy. The oral administration of propylthiouracil caused a prompt decrease (within twenty-four to seventy-two hours) in erythrocyte uptake in 5 of 6 hyperthyroid patients studied. Erythrocyte uptake was increased following administration of Dicumarol, in nephrosis, hepatitis, hepatic cirrhosis, and extensive metastatic malignancy.

The authors consider the *in vitro* erythrocyte method simple and rapid; it avoids administration of radioactive material to the patient and appears to permit assessment of thyroid function under conditions of exogenous iodine administration which prevent the use of serum PBI determinations and thyroidal I^{131} uptake studies. In several borderline cases and in patients who had been treated for hyperthyroidism, results of this test appeared better correlated with the ultimate definition of thyroid status than were the results of other diagnostic methods. Also, erythrocyte I^{131} uptake appears to be of diagnostic value in the face of certain non-thyroid factors which complicate the interpretation of various other methods, *e.g.*, anxiety, hypertension, congestive failure, polycythemia, and the administration of mercury.

Two figures; 1 table. JAMES E. BAUER, M.D.
University of Missouri

The Use of I^{131} Triolein in the Study of Absorptive Disorders in Man. Paul Beres, Julius Wenger, and Joseph B. Kirsner. Gastroenterology **32**: 1–16, January 1957. (J. B. K., 950 E. 59th St., Chicago 37, Ill.)

Malabsorption of fat and fat-soluble substances is a frequent accompaniment of diseases of the gastrointestinal tract. Recognition of these disorders and understanding of their pathogenesis have been retarded by the lack of simple, accurate methods for the measurement of fat absorption and excretion in man. The measurement of lipid I^{131} levels in whole blood, following ingestion of a test meal containing I^{131} triolein has proved to be a useful adjunct in the evaluation of these malabsorptive syndromes. The advantages of the radioactive method over the usual technics are several: rapidity, simplicity, and the possibility of frequent repetition with a minimum of laboratory personnel.

A characteristically flat absorption pattern was observed in 5 cases of idiopathic steatorrhea. Prompt improvement in this pattern occurred in 3 cases following administration of prednisone. In 2 patients with sprue-like syndromes which failed to respond clinically to the drug, the I^{131} triolein pattern also failed to improve.

In 8 patients with pancreatic disease, there was good correlation between the I^{131} triolein study and the degree of steatorrhea. Since the pancreas has considerable functional reserve, this test fails to detect mild impairment of pancreatic function.

Two patients with obstructive jaundice and normal pancreatic function had low absorptive patterns. The triolein test cannot differentiate biliary tract from pancreatic disease in the presence of obstructive jaundice.

In patients with steatorrhea following gastric resection, the I^{131} triolein absorptive patterns correlated well with the coefficients of absorption. Disagreement was not observed in regional enteritis, where normal absorptive patterns often were associated with steatorrhea.

The authors suggest that the I^{131} triolein method should replace the Vitamin A and chylomicron technics in man in the clinical evaluation of absorptive disorders.

Eighteen graphs. JOHN P. FOTOPOULOS, M.D.
Hartford, Conn.

The Use of I^{131} Labeled Fat in the Study of Fat Digestion and Absorption in Normal Individuals and in Patients with Diseases of Fat Absorption. R. D. McKenna, R. H. Bourne, and A. Matzko. Gastroenterology **32:** 17–24, January 1957. (R. D. M., 1390 Sherbrooke St. W., Montreal, Province of Quebec, Canada)

A method is described for the study of fat absorption and metabolism by measuring the fecal excretion in blood serum levels after the administration of a test meal of I^{131}-labeled glycerol trioleate added to a high-grade olive oil. Fifty microcuries of I^{131} was found to be adequate. This study included 15 control subjects, 7 subjects with impaired absorption of fat, and 3 subjects who had undergone partial gastrectomy.

Peak levels of radioactivity in 13 of the control group occurred at three to four hours after ingestion of the I^{131}-labeled fat. In 2 subjects of this control group the serum level rose gradually and reached the highest recorded level at 9 hours. This was probably due to the delay in gastric emptying. In the cases with known impaired fat absorption, the serum isotope levels were very low and the curves were flat. The subjects with subtotal gastrectomy showed a fairly rapid rise in serum radioactivity within the first hour followed by a persistent plateau to the fourth hour. This was an indication that there was rapid passage of the test meal from the gastric pouch into the small bowel.

The fecal excretion of the isotope in the control group was 4 per cent or less of the ingested dose and appeared to be independent of the pattern of the blood absorption curve. In the group with known impaired fat absorption from various causes, the fecal excretion ranged from 12.2 per cent to 30 per cent of the ingested dose.

The authors feel that, although the blood curve is a good indicator of absorption rate, the I^{131} stool recovery is a better indicator of total absorption of the labeled fat.

One photograph; 2 graphs.

JOHN P. FOTOPOULOS, M.D.
Hartford, Conn.

The Evaluation of Pancreatic Function by Use of I^{131} Labeled Fat. William W. Shingleton, George J. Baylin, Joseph K. Isley, Aaron P. Sanders, and Julian M. Ruffin. Gastroenterology **32:** 28–32, January 1957. (W. W. S., Duke University, Durham, N. C.)

The authors carried out a study using an I^{131}-labeled fat meal on 30 patients with proved pancreatic disease. The test meal consisted of 50 microcuries of I^{131}-labeled glycerol trioleate with 0.5 c.c. of peanut oil per kilogram of body weight, emulsified in an equal amount of water and 2 to 3 c.c. of Tween 80. Measurements were made of the per cent of blood radioactivity at four, five, and six hours following the test meal, and on a subsequent forty-eight-hour collection of feces. The test yielded information of diagnostic value in 10 of 12 patients found to have chronic relapsing pancreatitis, and in 17 of 18 patients with pancreatic carcinoma. In the absence of small bowel disease, pyloric obstruction or gastric surgery, an impairment of fat absorption determined by this technic is strongly suggestive of pancreatic disease.

The authors agree with others that the pancreas is an organ possessing large functional reserve, and minor degrees of pancreatic disease would not impair fat digestion. Carcinoma arising in the head of the pancreas, wherein major ducts are occluded, is associated with the most consistent alteration in fat absorption. This test, like all pancreatic function tests, makes no distinction between benign and malignant disease of the organ. The method is useful also as a laboratory aid in evaluating substitution therapy in patients with pancreatic insufficiency.

Two tables.

JOHN P. FOTOPOULOS, M.D.
Hartford, Conn.

Lymphatic Circulation Studied with Radioactive Plasma Protein. G. W. Taylor, J. B. Kinmonth, E. Rollinson, J. Rotblat, and G. E. Francis. Brit. M. J. **1:** 133–137, Jan. 19, 1957. (St. Bartholomew's Hospital, London, England)

Plasma protein labeled with radioactive iodine (R.P.P.) was used to study the lymphatic circulation in the hope of finding answers to three questions: (1) Are extravascular protein molecules removed solely by the lymphatics or does absorption by the blood capillaries occur? (2) Does the absorption of protein from the subcutaneous tissues of lymphedematous patients differ from that in normal subjects? (3) Could the removal rate of R.P.P. from the subcutaneous tissues be used as a test of lymphatic function in clinical practice?

Six normal subjects and 10 patients suffering from lymphedema were studied. Similar investigations were made in rabbits, comparing normal animals with those suffering an acute lymphatic transection making the limb edematous. In addition, the clearance rate of crystalloid solution iodide (I^{131}) from the subcutaneous tissues was determined in some patients and animals.

A preparation of 1 to 2 ml. of 2 per cent protein solution containing 0.5 to 1.0 mc of I^{131} per ml. was injected subcutaneously into the limbs of patients and normal subjects, usually in amounts of 0.1 ml., containing about 100 microcuries of I^{131}. When the specific activity of the R.P.P. was low and a larger volume had to be used, several injection sites were employed, close enough together to be regarded as a single site for counting purposes. No more than 0.1 ml. of R.P.P. solution was injected at any one site.

The arrival of R.P.P. in the blood was estimated in 5 patients and 4 normal subjects by taking 3-ml. samples of venous blood from an arm vein. Frequent specimens were obtained during the first twelve hours and sampling was continued at intervals for seven days. The diagnosis in 4 of these patients was lymphedema praecox of the legs. The remaining patient had an edematous arm following invasion of the axillary nodes by carcinoma of the breast. One patient had unilateral edema and her normal leg was studied and included in the normal control group.

Local counting over the injection site showed a wide subcutaneous diffusion of R.P.P. around the point of injection, influenced by gravity and greater in the lymphedematous patients than in the normal controls. From estimations of the appearance in the blood stream of the injected R.P.P. it was demonstrated that there is a time delay, greater in patients with severe lymphedema, of from one-half to three and a quarter hours following the subcutaneous injection before the R.P.P. can be detected in the blood; also, that the initial rate of rise of R.P.P. content in the blood in normal control subjects is increased by physical activity and is greater than in the patients with lymphedema.

In the experimental animals R.P.P. was injected subcutaneously into the paw of the transected leg. Blood specimens were obtained by means of a "polythene"

tube inserted in the superior vena cava *via* the jugular vein. In normal rabbits, there is a delay in time, of the same order of magnitude as that observed in human subjects, following the injection of R.P.P. before its detection in the blood. In the transected animals, however, R.P.P. could be found in the blood immediately following its injection, despite which, the initial rate of rise of R.P.P. content in the blood was greater in the control animals.

It appears from these studies that, rather than passing from the tissue fluids directly into the blood through the capillary walls, R.P.P. is absorbed into the lymphatic system with a subsequent discharge into the blood system. Longer delays in passage and correspondingly slower subsequent rates of increase of R.P.P. in the blood are associated with slower functioning of the lymphatic system. The lymphatic system, then, would seem to be the most important mechanism for the transport of proteins from the tissue fluids. Because of iodide contamination of the R.P.P. used in this study, it was impossible to decide whether there is a return of a small proportion of protein directly to the blood through the capillary walls.

In the transected animals, the lymphatic route is destroyed and the normal physiological conditions are disturbed by trauma, so that appreciable passage of R.P.P. in the reverse direction through the capillary walls becomes possible. Even in these conditions the removal of protein from the tissue, as measured by the initial rate of increase of R.P.P. in the blood, is about three times slower than in the normal rabbit.

The results of this investigation indicate that the behavior of R.P.P. injected subcutaneously can be used as a test of lymphatic function. The method is useful as a research tool, but is too expensive and time-consuming for routine clinical purposes.

Four graphs; 3 tables.

Radioactive Phosphorus in Differential Diagnosis of Ocular Tumors. Special Reference to Results of University of Michigan Study, July 1954–May 1956. Irving Shapiro. Arch. Ophth. **57**: 14–17, January 1957. (University Hospital, Ann Arbor, Mich.)

One of the most difficult problems in ophthalmology is the differential diagnosis between benign and malignant intraocular lesions. Not only does this involve the difficulties common to such a diagnosis in any body location, but in many lesions a biopsy cannot be performed without irretrievable functional damage.

In the author's experience, the differential uptake of P^{32} by malignant ocular tissue can be a definite adjunct in the study of malignant neoplasms. The usual adult patient is given 500 μc of P^{32} intravenously, while for children the dose is adjusted downward on a weight basis. Technics of anterior and posterior counting are described. It has been found that the most significant results are obtained by a single evaluation forty-eight hours post-injection. Eighty countings have been performed without incident. Three of these were on the same patients counted twice, some months apart, with the same results. Twenty-four of the cases have been proved pathologically, and it is on this group that the author bases his discussion. This, of course, weights the report in one respect, as it is only the most suspicious lesions which come to operation. Even in this group weighted toward operation, there were three false negatives. In 1 case of malignant melanoma of the choroid the results were at variance negative with the anterior count and positive with the posterior count.

Stress is laid upon the necessity for individualization of criteria of positivity. This is illustrated by a case of malignant melanoma of the iris. This lesion had 18 to 22 per cent greater uptake than the control area in the other eye. However, the lesion had 38 per cent excessive uptake over its own eye background, while the control area in the opposite eye was 5 per cent over its own background. The results were correctly reported as positive.

Conservatism in use of the test is advised.

Radioactive Phosphorus. III. In the Treatment of Malignant Lymphomas, Plasma-Cell Myeloma, Ewing's Sarcoma, and Osteogenic Sarcoma. Henry D. Diamond, Lloyd F. Craver, and Helen Q. Woodard. Cancer **10**: 143–150, January-February 1957. (Memorial Center for Cancer and Allied Diseases, New York, N. Y.)

This paper reports the authors' experience with radiophosphorus (P^{32}) in the treatment of patients with various forms of malignant lymphomas, plasma-cell myeloma, endothelial myeloma (Ewing's sarcoma), and osteogenic sarcoma. They have reported previously on the use of P^{32} in lymphatic leukemia (Cancer **3**: 779, 1950. Abst. in Radiology **57**: 299, 1951) and in myeloid leukemia (Cancer **4**: 999, 1951. Abst. in Radiology **59**: 312, 1952). The P^{32} was administered orally. In some few instances, a schedule of small, frequently given doses was employed. In the majority of the patients, however, a full course of P^{32} was instituted initially, followed by a period of observation.

Radiophosphorus was found to be ineffective in the treatment of 60 patients, of whom 4 had Hodgkin's disease; 31 lymphosarcoma; 9 reticulum-cell sarcoma; 4 mycosis fungoides; 3 plasma-cell myeloma; 2 Ewing's sarcoma; and 7 osteogenic sarcoma. The reasons for such failure inherent in the properties of the P^{32} and in the normal and tumor tissues are discussed.

A Quantitative Study of the Radiosensitivity of Chronic Leukaemia. E. C. Easson. Brit. J. Radiol. **30**: 35–39, January 1957. (Christie Hospital and Holt Radium Institute, Manchester, England)

Since the white blood count in chronic leukemia falls exponentially with integral body dosage from P^{32}, the half-value dose is a quantitative expression of leukopoietic sensitivity for each individual. With this premise in mind, the author investigated a series of 27 cases of chronic myeloid and 21 of chronic lymphoid leukemia to determine if any correlation existed between the radiosensitivity of the white cells and a variety of data which are commonly considered to reflect the activity of the leukemic process. The cases were tabulated in order of decreasing white cell sensitivity to P^{32}. The following data on each patient were also tabulated: sex, age, percentage of immature cells in the blood, the initial white cell count, anemia, the size of the spleen, lymph node enlargement, general condition, duration of remission, and body weight.

It was found that in no instance was there a correlation between any of the aforementioned factors and the white cell sensitivity. This study, says the author, would seem to suggest that leukemic white cells or the hemopoietic marrow from which they arise respond with a sensitivity which bears no relationship to the underlying disease process, and that the prognosis in any

case, both in terms of the quality of a remission and duration of survival, bears no relationship to intrinsic white cell sensitivity.

One figure; 2 tables. JAMES F. NICHOLS, M.D.
Cleveland City Hospital

Distribution and Effect of Colloidal Chromic Phosphate (P^{32}) Injected into the Hepatic Artery and Portal Vein of Dogs and Man. Bennett Levine, Henry Hoffman, and Samuel O. Freedlander. Cancer **10:** 164–172, January-February 1957. (Hilda M. Stone Radioactive Isotope Laboratory, Mt. Sinai Hospital, Cleveland, Ohio)

The studies reported in this paper were in two parts, those in dogs and those in patients. In the first, the authors tried to determine if large doses of radioactivity in the form of colloidal chromic phosphate could be deposited within the liver of dogs without killing the animals or causing irreparable liver damage. In the latter, doses of radioactive colloidal chromic phosphate calculated to deliver between 6,500 and 10,000 rep to the liver were injected into 4 patients with far-advanced carcinoma of the liver. The portal vein and hepatic artery were chosen as the routes of administration in order to concentrate as much of the material in the liver as possible.

These studies showed that, after injection of colloidal chromic phosphate into the portal or hepatic artery of the dog, 94 per cent of the material is immediately removed by the liver. The radioactivity, once deposited within the liver, is retained in that organ. Doses of radiation varying from 500 to 24,000 rep, delivered to the liver of dogs in fourteen to one hundred and thirteen days, caused no significant impairment of liver function, and no significant histologic changes in the liver were found at autopsy, provided the intrahepatic distribution was uniform.

Although uniform distribution of radioactive colloidal chromic phosphate can be obtained in normal liver tissue in dogs, it appears that this material cannot be deposited to any significant degree within malignant tumor tissue in the human liver. In the 4 patients studied, almost all the radioactivity was localized in normal liver tissue. Except for the development of hypoplasia of the bone marrow in 1 case, there was no evidence of any significant effect on the course of the disease. It appears that normal human liver, as well as the liver of dogs, can tolerate large doses of radiation without any immediate ill effects on liver cells and liver function.

Seven figures; 3 tables.

Oxalate Inhibition of Phosphate Loss from Erythrocytes of Carcinoma Patients. Allen F. Reid, Richard C. Gilmore, Jr., Jack K. Jeanes, and Margaret C. Robbins. Cancer **10:** 161–163, January-February 1957. (Department of Biophysics, University of Texas Southwestern Medical School, Dallas, Texas)

It has been shown that the rate of loss of metabolized radioactive phosphate, after incubation of red cells in their own plasma, is greater for patients with cancer than for patients without cancer (Reid and Ryan: Cancer **4:** 184, 1951). The possibility exists that the effect is the result of (1) an inherent metabolic difference between the cells of the two groups, (2) a difference in the plasma of the two that affects the metabolism of the cells, or (3) a combination of both these. In order to clarify the situation, experiments were designed to determine if there was a difference in the phosphate metabolism of erythrocytes, independent of the plasma, between cancer patients and a control group. The authors report an investigation of the loss-rate of inorganic P^{32} from erythrocytes when removed from their plasma and incubated in standard media.

When oxalate and dextrose were present in the incubation medium containing the P^{32} to be metabolized, the loss rate was decreased.

The proportionate decrease of P^{32}-loss rate from fresh cells was greater for subjects with carcinoma or portal cirrhosis than for normal subjects or those with other diseases. This difference disappeared after cell storage of more than forty-eight hours.

Three figures; 1 table.

Dosage Distributions from "Hairpins" of Radioactive Tantalum Wire. J. L. Haybittle. Brit. J. Radiol. **30:** 49–52, January 1957. (Radiotherapeutic Centre, Addenbrooke's Hospital, Cambridge, England)

Using film dosimetry, the author measured the dose distribution in the region surrounding implants of one to three radioactive tantalum "hairpins," placed side by side in a plane arrangement. The experimentally derived values were found to correspond in a reasonably satisfactory manner with calculations based on the Manchester dosage system, with allowance for the open end of the "hairpin." The author concludes that the calculated minimum tumor dose does represent the true minimum dose over a large area of the implant but that the dose falls below this level in the region near the open ends. The relative area under-dosed increases as the number of hairpins decreases. It is felt that calculation on the above basis provides a reasonably satisfactory estimate of tumor dosage providing the open ends of the "hairpins" project 1.5, 1.0 or 0.5 cm. beyond the area requiring treatment, according as one, two, or three hairpins are used.

[It is of interest to note that, because of the uniform linear activity of the tantalum wire sources, the implants obtained with these "hairpins" are not "ideal" according to the Manchester point of view, but become very similar to implants made in the United States in which radium needles of uniform linear activity are uniformly spaced. For this reason it would seem that the Quimby tables, which are based upon uniform distribution of activity rather than upon uniform dosage, would be more applicable to calculations for this type of implant than would the Manchester dosage system.—J. E. B.]

Five figures. JAMES E. BAUER, M.D.
University of Missouri

A Study of Toxic Doses of Strontium-90 (Sr^{90}) in the Adult Rat. W. A. D. Anderson, Gloria E. Zander, and Joseph F. Kuzma. Arch. Path. **62:** 433–440, December 1956. (W. A. D. A., University of Miami School of Medicine, Coral Gables, Fla.)

An outstanding metabolic characteristic of radioactive strontium is its selective deposition in the skeleton. Three days after injection the total accumulation in soft tissues represents less than 1 per cent of that in bone. Moreover, it is eliminated very slowly from the skeleton. It causes severe hematopoietic suppression and radiation injury of growing bone, which is followed by repair and, in time, by osteogenic sarcoma.

The authors' experiments showed Sr^{90} to be more potent than Sr^{89} in all of its radiation effects. This greater

effect is related to its long half-life and its radioactive daughter Y^{90}, which has a high maximum energy and with which it is in equilibrium.

The LD 50/30 days for Sr^{90} in the rat is slightly less than 2.5 μc per gram.

Multiple injections of Sr^{90} are cumulative, and the biological effects are a function of the total dose.

One autoradiogram; 4 graphs; 4 tables.

Cancerogenic Effects of Ca^{45} and Sr^{89} on Bones of CF_1 Mice. W. A. D. Anderson, Gloria E. Zander, and Joseph F. Kuzma. Arch. Path. **62:** 262–271, October 1956. (W. A. D. A., University of Miami School of Medicine, Coral Gables, Fla.)

This investigation was designed to study the long-term cancerogenic effects of Ca^{45} and Sr^{89} on the bones of CF_1 mice. It was found that osteogenic sarcoma may be induced in virgin female CF_1 mice by Ca^{45} given intraperitoneally in a single large dose or in small weekly injections. Osteogenic sarcoma may also be induced in virgin female CF_1 mice by Sr^{89} given intraperitoneally in multiple weekly injections. Tumors induced by Sr^{89} are located chiefly in the limbs, while those induced by Ca^{45} are found chiefly in the spine and pelvis. No malignant bone tumor developed in a control series.

Of the 23 tumors in mice given Ca^{45} or Sr^{89}, 5 were osteomas. In 2 control mice osteomas developed.

Benign tumors of bone are uniformly radiopaque and are sharp in outline. Malignant tumors are irregularly radiopaque and less well defined.

Three roentgenograms; 1 autoradiogram; 3 photomicrographs; 7 tables.

Discrimination of Calcium and Strontium by the Kidney. N. S. MacDonald, P. Noyes, and P. C. Lorick. Am. J. Physiol. **188:** 131–136, January 1957. (University of California School of Medicine, Los Angeles, Calif.)

Skeletal retention and excretion of strontium were directly compared with those of calcium following injection of solutions containing both radioisotopes, Ca^{45} and Sr^{90}, into rats and rabbits. In normal animals, a greater fraction of the injected dose of Ca^{45} was retained in the skeleton than was observed for Sr^{90}. In complementary fashion, the fraction of the injected Sr^{90} which appeared in the urine was greater than the fraction of the dose of Ca^{45} which was excreted. However, in rats in which tibial fractures were actively calcifying, this difference disappeared. The enhanced accumulation of radioactivity in deposits of new bone had the same ratio of Sr^{90}: Ca^{45} as the solution injected. Furthermore, when the functions of the kidneys of normal rabbits were impaired by poisoning with mercuric chloride or were completely extinguished by nephrectomy, again the usual differences in Ca^{45} and Sr^{90} deposition in bone tissue disappeared.

When plasma containing both Ca^{45} and Sr^{90} were shaken with powdered bone, both radioisotopes were extracted in equivalent amounts.

It is concluded that the avidity of bone tissue, *per se*, for strontium ions is not discernibly different from that for calcium ions. The retention by the skeleton of a larger fraction of an injected quantity of calcium than of a simultaneously administered strontium was attributed, in part, to a renal discrimination causing a greater relative loss of strontium to the urine.

Three tables. AUTHORS' ABSTRACT

Studies of Interstitial Radiolutetium (Lu^{177}) in the Dog. William M. Christopherson, Harold F. Berg, G. C. Kyker, and Marshall Brucer. Arch. Path. **62:** 441–444, December 1956. (W. M. C., University of Louisville School of Medicine, Louisville, Ky.)

Lutetium 177 (Lu^{177}) is a radioisotope which might have some advantages as a source of selective radiation for the reticuloendothelial system. As with other rare earths, hydrolysis of ionic lutetium approaches completion before it reaches the *p*H of blood. The hydroxide is insoluble, and its rapid removal from the blood and deposition largely in the liver and spleen suggest colloidal properties.

The great limiting factor of Lu^{177}, as with Au^{198}, is its nonhomogeneous intranodal distribution. In the case of Au^{198} this lack of uniformity in distribution is somewhat negated by the relatively stronger gamma component. Lutetium has fewer gamma radiations per disintegration, and they are of lower energies. Although Lu^{177} appears to be inferior to Au^{198} in this respect, it has other characteristics which are in its favor. The half-life of 6.7 days, as compared with 2.7 days for Au^{198}, would make it more useful when distance of shipping is a factor. In this respect the low-energy gamma radiations make it easier to ship and less hazardous to handle. Finally, the tissues tolerate the local concentration of lutetium much better than they do radiogold. Severe reactions at the injection site are thus avoided.

Further studies are in progress to determine whether or not a better uniformity of intranodal distribution of Lu^{177} can be obtained.

Four autoradiograms.

Radioisotope Scanning as a Guide to Needle Biopsy of the Liver. Carroll M. Leevy and Joseph Greenberg. Am. J. M. Sc. **233:** 28–34, January 1957. (J. G., Radioisotope Laboratory, U. S. Naval Hospital, St. Albans, L. I., N. Y.)

Clinical detection of localized hepatic lesions, such as metastases, granulomas, abscess, hematoma, and focal necrosis or fibrosis, is quite often difficult. To date, diagnosis has been mostly speculative and usually dependent upon indirect methods. The authors have explored the possibility of needle biopsy of suspicious areas after a tracer dose of I^{131}-tagged human serum albumin (RIHSA). Their clinical material included 14 cancer patients who were suspected of having hepatic metastases but in whom clinical evaluation was indecisive, 20 patients with a provisional diagnosis of granuloma involving the liver, and 20 with diffuse hepatocellular disease. These patients were given 300 microcuries of RIHSA intravenously, and twenty-four hours later the liver was scanned with a directional scintillation counter. Needle biopsy was then performed at the site of greatest increase of radioactivity over the previously established control values.

Others (see Stirrett, Yuhl, and Libby: Surg., Gynec. & Obst. **96:** 210, 1953. Also Radiology **61:** 930, 1953) have reported an increased uptake of intravenously administered radioactive iodinated human serum albumin by metastatic lesions to the liver, frequently as much as 30 per cent over the values established for control subjects. Using the radioactive tracer method as a guide to needle biopsy in 14 patients with possible hepatic metastasis, the authors obtained a positive histologic diagnosis in 5. In 2 patients with metastatic lesions, biopsies in an area not demonstrating localiza-

tion of RIHSA showed normal liver, whereas biopsy over the "hot spots" yielded neoplastic tissue.

Radioisotope studies of patients with suspected granulomatous involvement of the liver showed that such lesions cause much smaller increases in radioactivity than do neoplasms. However, here too the combined use of radiosurvey and needle biopsy appears to improve the chance of obtaining a positive biopsy.

Investigation of diffuse liver disease by the radioisotope survey technic showed poor correlation between localization of radioactivity and histopathology. Serial observations in patients with viral hepatitis and nutritional cirrhosis demonstrated no consistent relationship of radioactive patterns to observed clinical, biochemical or histologic abnormalities.

The authors conclude that detection of focal anatomical abnormalities in the liver is facilitated by radioisotope localization followed by needle biopsy at the site of increased radioactivity.

Two roentgenograms; 1 chart.

J. P. CHAMPION, M.D.
Grand Rapids, Mich.

Designing Sensitive Plastic-Well Counters for Beta Rays. W. S. Michel, G. L. Brownell, and J. Mealey, Jr. Nucleonics **14:** 96–100, November 1956. (W. S. M., Bell Telephone Laboratories, Murray Hill, N. J.)

Design criteria are presented for well type scintillation counters which are capable of discriminating between the different beta spectra of a mixture of radioactive isotopes. This technic offers promise in multiple tracer experiments, particularly in conjunction with gamma ray detection.

With selective measurement in mind, the authors have designed and operated plastic scintillation well detectors for beta rays. The principal subjects of their investigation are wall thickness, gamma response, discriminator voltage, absorber thickness and sample nature.

Some advantages claimed over Geiger-Müller counters are: no special sample preparation, large sample volume, or cleaning of the apparatus is required. For medium and high-energy beta emitters the efficiency is comparable to or better than that of Geiger-Müller counters. The scintillation method is superior in offering higher resolution time, greater freedom in choice of detector geometry, and a high degree of correlation between absorbed energy and output pulse height.

Graphs are given showing the effect of variation of scintillator wall thickness for various beta energies, absolute efficiencies of 1/8 inch and 1/16 inch plastic wells as a function of maximum beta energy, and effect of absorber thickness and sample volume on detection efficiency.

Eight figures; 1 table. ROSS GARRETT
Memorial Center, New York

Large Plastic Well Makes Efficient Gamma Counter. G. J. Hine and A. Miller. Nucleonics **14:** 78, October 1956. (VA Hospital, Boston, Mass.)

The use of a plastic well type scintillator instead of the usual sodium iodide is described. A sensitivity twenty times as great as that of the standard NaI well is claimed, whereas the background is increased by a factor of only 2 or 3.

This has advantage in some medical applications where a small activity is contained in a large volume, as when a tracer is excreted in the urine. It is pointed out that a wall of a plastic phosphor 2 inches thick will count high-energy gammas with about the same efficiency as a 1/2-inch NaI wall.

A description of the physical arrangement of the well is given, with some figures and graphs indicating its characteristics. One microcurie of Co^{60} gives about 550,000 cpm with a background of 600 cpm.

Three figures. ROSS GARRETT
Memorial Center, New York

A CsI (T1)-Crystal Surgical Scintillation Probe. C. C. Harris, R. R. Bigelow, J. E. Francis, G. G. Kelley, and P. R. Bell. Nucleonics **14:** 102–108, November 1956. (Oak Ridge National Laboratory, Oak Ridge, Tenn.)

A compact scintillation detector using a CsI (T1) crystal mounted at the end of a Lucite light pipe is described. The sensing elements are mounted on a photomultiplier-preamplifier combination that is small enough to be held in the hand. The entire probe is hermetically sealed and can be solution-sterilized. The probe has been used in actual operations and has proved to be capable of localizing activities representing differential uptakes of less than a microcurie of I^{131} in volumes of the order of 10 mm^3.

A description of the electronic circuitry is given, followed by a case history. A 40-year-old woman who had had a total thyroidectomy showed a small iodine uptake (1.3 per cent at twenty-four hours) two years after the operation. The region was explored surgically and the scintillation probe used to locate the hot spot, which was found to be a small nodule of thyroid tissue 5 mm. in diameter. The locating of this nodule would have been impossible without the aid of the instrument described.

Four figures. ROSS GARRETT
Memorial Center, New York

Ag-Phosphate Glass Needles for Measuring Gamma Dose. A. L. Riegert, H. E. Johns, and J. W. T. Spinks. Nucleonics **14:** 134–137, November 1956. (University of Saskatchewan, Saskatoon, Sask., Canada)

Small silver-activated phosphate glass needles 1 mm. in diameter and 6 mm. long have been adapted to x-ray and gamma ray dosimetry. Their small size suggests the possbiility of using them for the measurement of x-ray and gamma ray dose distributions.

The authors have tested this possibility by determining the response of the needles in a water phantom irradiated with Co^{60} gamma rays and comparing the dose distribution obtained with that established by conventional ionization chamber measurements.

The main difference between the glass needle results and the conventional isodose was approximately 5 per cent when the dose was greater than 20 per cent of the surface dose. Somewhat larger differences were found where the dose was lower. Glass needles have advantages over small ionization chambers in applications such as measuring dosages in acid media, in masses of animal or vegetable matter, etc. The authors have not evaluated the performance of these needles under soft irradiation.

Two figures; 1 table. ROSS GARRETT
Memorial Center, New York

RADIATION EFFECTS—PROTECTION

Permissible Dose Problems with Special Reference to Diagnostic Procedures. M. H. Poppel, H. G. Jacobson, J. Stein, and G. J. Jerry. Am. J. Roentgenol. **77:** 138–143, January 1957. (M. H. P., 550 First Ave., New York 16, N. Y.)

The authors emphasize the necessity for some type of permanent recording of roentgen dosages received by patients undergoing diagnostic radiological procedures; similar records of exposures of personnel supervising or performing such examinations are highly desirable.

A simple method is presented for recording doses received by patients undergoing the usual diagnostic filming procedures. A chart is stamped or printed on the patient's film envelope. At each filming a note is made of the type of examination and the roentgen dosage received. In instances where fluoroscopy has been employed, the exposure time obtained from a timer is translated into its roentgen equivalent, utilizing the proper line on the table as determined by the kv, ma, and target-skin distance for the particular installation. The entire computation and recording procedure requires only a very short time.

In the case of radiologic personnel, dosage data are obtained from numerous dosimeter chambers attached in various areas over the examiner's body during a typical day of fluoroscopic and radiographic study. Such data are transferred to individual "radiation diaries" and maintained for future referral. The measured dosage on an "average day" is assumed to apply for each work day.

The authors admit that their methods are rough and approximate but feel that they represent a start in the important process of recording exposures to ionizing radiations.

One photograph; 2 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Postradiation Bone Sarcoma. Report of Eleven Cases. Miguel Cruz, Bradley L. Coley, and Fred W. Stewart. Cancer **10:** 72–88, January-February 1957. (B. L. C., Memorial Center for Cancer and Allied Diseases, New York, N. Y.)

In 1948, Cahan *et al.* (Cancer **1:** 3, 1948. Abst. in Radiology **52:** 619, 1949) reported 11 cases of sarcoma arising in irradiated bone. The purpose of the present study is to bring up-to-date the follow-up on the 4 survivors among these 11 cases and to add 11 more cases from the Memorial Center (New York). Two of those living with disease at the time of the 1948 reporting have since died, seven and eleven years after roentgen therapy was administered. One of the other 2 survivors remained well and free of metastasis or recurrence for twelve years. The other, who underwent a right interscapulothoracic amputation in 1935 for an osteogenic sarcoma that arose in the proximal humeral epiphysis thirteen years after roentgen therapy for a histologically proved juvenile cyst, remained symptom-free for seven years and then died, tumor-free, of a coronary occlusion.

The more recent series consists of 7 men and 4 women. The age at which the diagnosis of osteogenic sarcoma was established ranged from twelve to sixty-seven years. The silent interval between the completion of roentgen therapy and the establishment of microscopic proof of osteogenic sarcoma varied from four to twenty-four years. Two cases involved primarily the femur, 2 the humerus, and 1 each the clavicle, mandible, phalanx of the hand, fibula, rib, scapula, and lumbar spine. The sarcomas arose in previously normal bone in 6 cases and in pre-existing bone lesions in 5. Of the cases arising in normal bone within the beam of radiation, the primary conditions for which roentgen therapy had been used were the following: lymphangioma 1, carcinoma of the breast 1, epidermoid carcinoma of the buccal mucosa 1, cellulitis of the nail bed and hyperkeratosis 1, Hodgkin's disease 1, and seminoma of the testis (prophylactic irradiation) 1. The cases arising in pre-existing lesions of bone were as follows: bone cysts 2 and giant-cell tumor 3. In the cases in which reasonably accurate calculation was possible, the total tumor dose ranged from 1,000 to 5,289 r, delivered over a period ranging from one month to nine years.

In the 11 cases, treatment was begun as soon as the diagnosis of osteogenic sarcoma was established microscopically. It consisted of amputation in 6 cases, maxillary and mandibular resection in 1, and high-voltage x-ray therapy in 3 . In 1 case treatment was symptomatic. Nine of the patients were dead at the time of the report; the other 2 were free of any evidence of disease after seven and four years respectively; both were subjected to amputation. In the 3 patients who received high-voltage radiation, improvement was short-lived, and extension of the lesion followed invariably. Seven of the 9 patients who died were known to have pulmonary metastases.

The authors consider at some length the relation of radiation to the subsequent development of bone sarcoma, justifying their view that when the type of sarcoma described here follows radiotherapy of a giant-cell tumor, it must be presumed that the osteogenic sarcoma has arisen not from the tumor but *de novo* from the irradiated field.

Fourteen roentgenograms; 7 photomicrographs; 1 photograph.

Bone Injuries Associated with Roentgen Ulcers. Jaromír Kolár and Radko Vrabec. Strahlentherapie **102:** 112–125, January 1957. (In German) (Karls-Universität, Prague, Czechoslovakia)

Skin damages take first place among the injurious side-effects of radium and roentgen therapy. Mature bones were long considered to be radioresistant until the appearance of Ewing's paper on irradiation osteitis in 1926 (Acta radiol. **6:** 399, 1926). In spite of an ever increasing number of reports, today's knowledge concerning radiation injuries to bones (osteoporosis, bone necrosis, and spontaneous fractures) is still unsatisfactory. Quite frequently they are mistaken for metastases and receive additional radiation.

The authors report their findings in 34 patients in whom ulcers developed following radiation therapy. In all cases the condition of the underlying bones was thoroughly investigated by radiographic studies. The ribs, due to their position directly under the skin and their proneness to circulatory impairment as a result of breast amputation, are readily affected by the traumatizing action of radiation. They react with osteoporosis and spontaneous fractures, mainly in the 2nd to 6th ribs, often involving several ribs simultaneously.

Similar changes were found, though rarely, in the clavicle. In 2 of the 34 patients a spontaneous fracture occurred at the middle third of the clavicle, which in one instance underwent sequestration.

Spontaneous fractures involving the femoral neck and the pelvic bones have been quite frequently reported and occur apparently because of the static demands of weight-bearing.

The authors' main interest centered in necrosis of the facial bones, especially the jaws, which often demonstrated the triad of irradiation effect, infection, and trauma.

The irradiation ulcers occurred from three months to fifteen years after the final treatment, with an average interval of six and a half years. All patients with ulcers also exhibited bone changes of about the same size as the skin lesion. The authors believe that the radiograph does not always reveal the serious histologic changes of the bone. It is impossible to determine exactly the moment of the manifestation of bone damage or to rule out possible future changes.

Because bone necrosis and spontaneous fractures can easily be mistaken for metastasis, the authors suggest the use of the following distinguishing characteristics: (*a*) necrosis in irradiated area only, not in other bones; (*b*) slow progression with tendency to healing; (*c*) increase with additional irradiation. Biopsy, which could be used, should be avoided whenever possible because of increased susceptibility to infection of the necrotic bone.

The majority of the patients required plastic operations, sometimes with surgical removal of the necrotic bone.

Twelve roentgenograms; 1 photograph; 1 table.

HERBERT POLLACK, M.D.
Chicago, Ill.

Extensive Sacral Radiation Carcinoma Superimposed on "Bathing Trunk" Nevus. M. E. Kurth and Tibor Benedek. Am. J. Surg. **93**: 147–150, January 1957. (25 E. Washington St., Chicago 2, Ill.)

A case is presented of a 37-year-old woman who, over thirty-two years previously, received an unknown amount of radiation to the posterior, inferior trunk and right lower extremity for a "bathing-trunk" type of birthmark. She gave a two-year history of a slowly enlarging sacral ulceration, which, when, biopsied revealed unequivocal squamous-cell epithelioma. Therapy consisted of wide and deep excision down to sacral periosteum, with primary, one-stage repair with split-thickness grafts.

All of the irradiated skin was not removed and the patient was being kept under continuous observation. There was no evidence of recurrence more than one year postoperatively.

Six photographs; 1 photomicrograph.

J. E. RHODENBAUGH, M.D.
The Henry Ford Hospital

The Association of Tumors and Roentgen-Ray Treatment of the Thorax in Infancy. C. Lenore Simpson and L. H. Hempelmann. Cancer **10**: 42–56, January-February 1956. (L. H. H., University of Rochester, School of Medicine and Dentistry, Rochester, N. Y.)

Of a group of 1,722 children who received radiation to the thymus gland between 1926 and 1955, 1,502 have been traced. Information was also obtained about 1,933 of their untreated siblings. The material came from one city in an East Coast state and one hospital on the West Coast. It was the subject of a Preliminary Report in RADIOLOGY **64**: 840, 1955.

Eighteen malignant tumors were reported among the treated children. This is a significant increase over the expected number and over the incidence among the siblings (5 malignant tumors). Certain benign tumors, allergic diseases, and heart and mental disorders also occurred more frequently.

The largest number of tumors occurred in the thyroid gland. These cases are briefly reviewed. No case occurred in a child receiving less than approximately 180 r to the gland. Cases of thyroid cancer following childhood radiation for other conditions are cited from the literature and from the authors' experience.

The incidence of leukemia was also found to be significantly increased, but the data are not sufficient to establish a definite relationship between this condition and either the radiation or the enlarged thymus gland. The possible significance of this finding is discussed in the light of other reports of leukemia following radiation in man and the known relationship between the thymus, leukemia, and irradiation in mice.

The data suggest also an increased number of osteochondromas in the bones falling within the radiation field and a possible increase in other tumors.

The authors conclude that further investigation should be made to determine whether these tumors are really the result of radiation. They apparently followed smaller doses of roentgen rays than those previously considered cancerogenic. In the meantime, it is recommended that children should not be exposed to radiation, however small the amount, without very careful weighing of the probable benefits against the possible dangers.

Three figures; 7 tables.

Radiation Reactions in the Heart. A. G. W. Whitfield and P. B. Kunkler. Brit. Heart J. **19**: 53–58, January 1957. (Queen Elizabeth Hospital, University of Birmingham, Birmingham, England)

Four cases are presented in which electrocardiograms showed evidence of myocardial damage following courses of x-ray therapy to the chest including the cardiac area. Two of the patients were treated for breast carcinomas, 1 for bronchial carcinoma, and 1 for lymphosarcoma. The patient with bronchial carcinoma died suddenly and unexpectedly shortly after the end of the course of therapy, but no histologic changes attributable to radiation were found in the heart. In the others the electrocardiographic abnormalities proved to be transitory and were not accompanied by symptoms or signs of cardiac embarrassment. Nevertheless, the authors recommend serial electrocardiograms when the heart is included in an area subjected to heavy irradiation.

Nine electrocardiograms.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Late Lesions in Man Caused by Colloidal Thorium Dioxide (Thorotrast). A New Case of Sarcoma of the Liver Twenty-Two Years After the Injection. Jorge da Silva Horta. Arch. Path. **62**: 403–418, November 1956. (Department of Pathological Anatomy, Faculty of Medicine, Lisbon, Portugal)

A case of angioblastic sarcoma of the liver in a man who had been given thorium dioxide (Thorotrast)

twenty-two years earlier is reported. Death in this case resulted from hemoperitoneum following rupture of the tumor. It is most likely that the Thorotrast had been injected for aortography; the quantity administered could not be determined.

In a review of the literature the author found 15 cases of tumor considered by various writers to be the result of the action of thorium dioxide, though not all of them can be accepted without criticism. The cases are listed in a table showing the purpose of the Thorotrast injection, the latent period, and the type of tumor developing. References to the original reports are furnished.

Thorotrast was largely employed in Portugal as an x-ray contrast medium as a result of the interest in methods of vascular investigation initiated by Egas Moniz, and a vast amount of material has been accumulated on the subject. Studies have been carried out by the author and his associates on the distribution of thorium dioxide in the body as time goes on and the lesions produced by the drug remaining in the body. Their findings are discussed at considerable length.

Fourteen figures; 2 tables.

The Determination of the Distribution of Internally Deposited Thorium by Means of Studies with a Realistic Phantom. J. Rundo. Acta radiol. **47:** 65–78, January 1957. (Finsen Laboratory, Finsen Institute, Copenhagen, Denmark)

The authors constructed a realistic phantom filled with water and containing models of lungs, liver, spleen, and skeleton, corresponding in size and form to a 70 kg. man. Known amounts of thorium were placed within the phantom liver and spleen, and topographical surveys were then made with a scintillation gamma ray counter. The figures derived from the correlation of the counts thus obtained with the amounts of thorium were utilized to calculate the thorium remaining in the liver and spleen of patients who had previously received thorium dioxide. Calculated amounts of residual thorium in these patients have agreed well with the amounts which had been actually received some years before, with allowance for washout of some of the decay products by the blood stream and for the change, with time, of activity of the decay products.

Similar data for soft-tissue deposits of thorium in the neck enabled the authors to calculate in some cases the amount of extravasated thorium adjacent to the site of injection (common carotid artery). Counting of blood samples from the patients were used to determine the radioactivity of decay products in the blood stream, and a total-body gamma ray monitor was used to determine overall body activity.

The results of the experiments revealed that calculations of the amount of residual thorium in spleen or liver were accurate to approximately 20 per cent. This was discovered by correlation of the calculated amounts with actual amounts found at splenectomy or in the liver and spleen of autopsied patients previously counted. In patients known to have no significant deposit of thorium in the tissues of the neck, the mean liver content was found to be 71 per cent of the total thorium injected and the mean spleen content 17 per cent. Of the remaining 12 per cent of the amount injected, the major part is likely to be in the red bone marrow.

The author concludes that, although little significance should be attached to the second decimal quoted in the results, fairly reliable calculations of dose rate and accumulated dose may be made, which are of value in assessing radiation damage and interpreting the clinical picture.

Four figures; 4 tables. JAMES E. BAUER, M.D.
University of Missouri

Quantitative Observations on Recovery from Whole Body Irradiation in Mice. R. H. Mole. Brit. J. Radiol. **30:** 40–46, January 1957. (Medical Research Council Radiobiological Research Unit, Atomic Energy Research Establishment, Harwell, England)

The author states that several experiments in the past have shown that the recovery rate from daily doses of irradiation is exponential. It was also suggested that the recovery rate itself was unaffected by previous irradiation. In his experiment to test the veracity of the assumption, CBA mice were irradiated on five days weekly at a constant daily dose, ranging from 25 to 200 r, to totals of 250 to 1,500 r. At each daily dose the proportion of deaths occurring within thirty days of the end of the period of irradiation increased with the total dose, and from this dose mortality curve the LD 50 for that particular daily dose was calculated. It was found that, during chronic irradiation, there is a progressive decrease in recovery rate as radiation damage accumulates (*i.e.*, recovery from one dose of radiation is affected by other doses of radiation given before or afterward).

A second experiment was planned in which CBA mice received doses from 10 to 50 r daily for five days a week. At the end of the course, an additional large dose of radiation was given, either immediately following the last daily dose or at a predetermined interval therafter, in order to determine the LD 50 for acute killing effects of the large additional dose. It was found that prolonging daily irradiation progressively interfered with the rate of recovery during the post-irradiation period, while scarcely altering the additional dose required to kill during the irradiation itself. Even with the same biological end-point and the same test of an additional single large dose of radiation, it appears that two aspects of recovery are involved, namely, that residual damage and recovery can in some respect be disassociated from each other, and that recovery rate and resistance to the killing effects of large single doses may vary independently. The author concludes that experiments using as their end-point the direct lethal action of radiation are of little value in assessing long-term hazards. Animals which have received enough radiation to ensure death from late effects may show little impairment of resistance to single large doses.

Three figures; 3 tables.

JAMES F. NICHOLS, M.D.
Cleveland City Hospital

The Distribution and *in Situ* Growth Pattern of Injected Rat Marrow in X-Irradiated Mice. Peter C. Nowell, Leonard J. Cole, Patricia L. Roan, and John G. Habermeyer. J. Nat. Cancer Inst. **18:** 127–143, January 1957. (Division of Biological and Medical Sciences, U. S. Naval Radiological Defense Laboratory, San Francisco, Calif.)

The modification of acute radiation injury in lethally irradiated mice by the injection of suspensions of isologous or heterologous bone marrow has been demonstrated by a number of workers. The authors used

Gomori's histochemical technic for alkaline-phosphatase to demonstrate the *in situ* growth pattern of rat marrow cells injected into irradiated mice.

Rat bone marrow (70 mg.) injected *intravenously* appeared as foci of phosphatase-positive cells in the spleen and in the marrow cavity of the recipient mice within five days. By the end of two weeks the spleen and bone marrow were largely repopulated by rat marrow elements, which apparently provided enough new peripheral leukocytes to prevent death from acute radiation in 65 per cent.

Rat bone marrow (350 mg.) injected *intraperitoneally* grew readily in the peritoneal cavity but did not appear as hematopoietic foci in the spleen and bone marrow until nine days after injection, too late to prevent the death of the animal.

Following intraperitoneal injection of isologous bone marrow (5 mg.), hematopoietic regeneration in the spleen and in the marrow cavity started within five to seven days and 70 per cent of the mice survived fifteen days.

Another group of mice was injected with 1 mg. of mouse marrow intravenously. The pattern of hematopoietic regrowth in these animals was similar to that seen in the mice receiving rat marrow intravenously but at a somewhat faster rate. By supplying large numbers of new cells to the peripheral blood, the transplanted marrow apparently enables the host to combat successfully the ordinarily fatal acute radiation illness. Ninety per cent of the animals in this group survived fifteen days.

In the group receiving intraperitoneal injection, all phases of regeneration occur somewhat later than in the mice receiving isologous marrow intravenously, and consequently the percentage of survival is lower in the intraperitoneally treated group. However, isologous marrow elements growing in the peritoneal cavity resulted in more rapid hematopoietic regeneration at other sites than did heterologous marrow.

Twenty-seven photomicrographs; 1 table.

W. T. CADMAN CHAFFIN, M.D.
Pittsburgh 19, Penna.

The Effect of Mercaptoethylamine on Survival of Mice Irradiated with Cobalt 60. D. J. Mewissen. Radiation Res. **6**: 85–97, January 1957. (School of Medicine, University of Liége, Liége, Belgium)

The protective action of β-mercaptoethylamine (Becaptan) against early radiation death was studied in mice irradiated with Co^{60}. A total of 485 C57BL/6 mice of both sexes, aged 38± 3 days, were assigned to treatment groups receiving four different total doses according to a graded sequence, in two fractions, with a five-day interval. The data were analyzed by the probit method. In the group treated with Becaptan, the thirty-day LD 50 value was increased from 416 to 700 r. The degree of protection afforded was statistically significant.

The death pattern was bimodal, and two components were identified. The deaths observed in the first wave seemed to be the result of an intestinal component; they appeared to be due chiefly to bacteremia and hemorrhage. In the second wave death could be attributed prominently to late effects of marrow aplasia.

An analysis of the data by two simultaneous probit regression curves is presented, assuming that the killing action of γ-rays is statistically similar to the joint independent action of two components. The mechanism of action of Becaptan is discussed accordingly. The degree of protection afforded by this agent against the first mode was moderate at any dose level of irradiation. The protection against late marrow death, however, was highly significant. At lower dosages, this component practically disappeared.

Nine figures; 3 tables.

Changes in the Cardiovascular System Following Total Body X-Irradiation. W. O. Caster, W. D. Armstrong, and Ernst Simonson, with the technical assistance of Judith Poncelet and Ada B. Simon. Am. J. Physiol. **188**: 169–177, January 1957. (University of Minnesota, Minneapolis, Minn.)

The cardiovascular system of the rat has been studied by both chemical and physiological methods following total-body x-irradiation with: (*a*) a single dose of 700 r (an LD 50 dose) and (*b*) chronic doses of 100 r/month or 200 r/month for a seven-month period. Histologic changes in the heart were absent. Marked chemical and physiological changes suggest, however, that some type of heart failure may be an important factor in the causation of radiation death.

In the first ten days after 700 r, there were (*a*) marked decreases in deoxyribonucleic acid and actomyosin concentrations in the heart, (*b*) an edema of the heart and lung, (*c*) an increased peripheral venous pressure, (*d*) electrocardiographic changes (including a progression of changes in rhythmicity), and (*e*) a change in the mechanical action of the heart. These effects were most pronounced at the LD 50 death period. Chronic irradiation with 100–200 r/month resulted in similar electrocardiographic changes. The heart and testes were the two tissues whose weights were most sensitive to chronic irradiation. Changes in the vascular system following 700 r are described in terms of alterations in tissue Evans blue space. In the heart there is a 30 to 50 per cent increase in plasma volume from six to ten days after irradiation.

Three figures; 5 tables. AUTHORS' ABSTRACT

Effect of Whole Body X-Irradiation on Plasma and Intestinal Cholinesterase and on Drug Responses of Isolated Intestinal Loops in the Rhesus Monkey, Rat and Guinea Pig. Arthur B. French and Patricia E. Wall. Am. J. Physiol. **188**: 76–80, January 1957. (Radiobiology Laboratory, University of Utah College of Medicine, Salt Lake City, Utah)

Cholinesterase activity and responses to pressure, acetylcholine, histamine, and eserine were studied in isolated intestinal loops from 15 Rhesus monkeys, 4 rats, and 31 guinea-pigs subjected to whole-body x-irradiation, and in loops from paired control animals. Ileal and jejunal nonspecific cholinesterase levels were reduced in rats forty-eight hours after 650 r, and in guinea-pigs forty-eight hours after 250 r, but not in Rhesus monkeys forty-eight hours and seven to nine days after 800 r. Monkey plasma cholinesterase levels showed only a small preterminal decrease when measured daily after 800 r.

The peristaltic responses of monkey and guinea-pig intestinal loops to intraluminal pressure were normal at the above intervals after radiation. In monkeys, rats, and guinea pigs the dose of acetylcholine required to elicit a contraction was unchanged by radiation, regardless of whether the threshold dose or the dose which pro-

duced 50 per cent of the calculated maximal response was measured. The height of the maximum contractile response of monkey ileal and jejunal loops to acetylcholine was greater at both time intervals after radiation than in control loops. This difference was not found in rats or guinea pigs or in monkeys after histamine or eserine.

These observations cast doubt on the idea that changes in intestinal cholinesterase activity or in the sensitivity of intestinal muscle to acetylcholine play a significant part in the vomiting and the changes in intestinal motor activity which follow irradiation.

Three figures; 3 tables. AUTHORS' ABSTRACT

Medical Progress: Radiation Exposure Patterns Aboard the *USS Nautilus*. John H. Ebersole. New England J. Med. **256**: 67–74, Jan. 10, 1957. (Medical Officer, *USS Seawolf*)

Problems relative to radiation protection and monitoring about the nuclear-powered submarine, *Nautilus*, are described and discussed in considerable detail. In general, the nature of the problem is not greatly different from that attending the operation of active radioisotope laboratories in hospitals or research centers. There are, however, some unique problems involved. For example, it is necessary for men to live within a relatively very short distance of a powerful nuclear reactor for prolonged periods of time. There is also the problem of a closed air system in effect with the ship submerged and with necessity of a fool-proof system of protection against air contamination and its management should it occur. There is the necessity of a careful checking of the integrity of the shield about the nuclear reactor and precautionary measures against leakage of any of the radioactive materials concerned with the operation of the reactor.

Radiation monitoring programs for personnel aboard the *Nautilus* include film-badge service for all and pocket dosimeters for those individuals having access to the area of the reactor. Constant monitoring devices with warning systems are utilized for air sampling. The ship contains a compact, self-sufficient radiation detection and analysis laboratory, including equipment for development and interpretation of film badges. Means of decontamination are similar to those used in shore installations except for their general compactness.

Radiation dosages received by the ship's personnel have been carefully recorded since the launching of this unique submarine. Data are analyzed over a one-year period. The average exposure to the ship's 106 men for one year was only 173 mrem (milliroentgen equivalent man) or approximately 1 per cent of the annual permissible amount of external radiation, by present standards. Engineering personnel having access to the area of the reactor received a somewhat higher average dose, 468 mrem per man per year, still far below the accepted safe limit. The general highly successful level of radiation protection can be appreciated by consideration of this statement: "It is interesting that outside the reactor compartment personnel receive less radiation when the ship is submerged [and the reactor operating] than they would receive on shore, owing to the shielding effect of the water on the cosmic radiations."

The article is interestingly written and is well worth reading by those interested in this type of problem.

Three figures. JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Estimation of Whole-Body Radiation Doses in Accidental Fission Bursts. Joseph G. Hoffman and Louis H. Hempelmann. Am. J. Roentgenol. **77**: 144–160, January 1957. (J. G. H., Roswell Park Memorial Institute, Buffalo 3, N. Y.)

The paper evaluates whole-body radiation doses sustained by 9 persons exposed to accidental fission bursts in two nuclear accidents occurring at the Los Alamos Scientific Laboratory. The methods of estimating radiation doses and the physical problems encountered in calculation of these doses are presented in considerable detail. In all 9 cases penetrating ionizing radiations were the sole cause of injury sustained by the exposed individuals. Injury to tissues was brought about by fast neutrons and gamma rays.

Designation of doses received may be in one of several ways, namely: (1) average value of the rep absorbed throughout the body; (2) total whole body dose in reps in the concept of integral dose; (3) dosage in terms of incident dose only; (4) specific activity of radioactive sodium in the blood serum, a measurement peculiar to neutron exposures. Methods of estimating or calculating dosages from each of the contributing factors are discussed.

This is a highly technical paper dealing with physical aspects of radiation.

Eleven tables. JAMES W. BARBER, M.D.
Cheyenne, Wyo.

The Effects of a High Explosive Blast in Mice with Radiation Injury. Carl-Johan Clemedson and Arne Nelson. Acta radiol. **47**: 79–85, January 1957. (Research Insitute of National Defence, Department 1, Sundbyberg, Sweden)

To estimate the effects of high explosive blast combined with radiation injury, the authors used 630 white male mice of pure breed, weighing about 21 gm. each. They were grouped in twenties, except in the control experiments, where groups of 10 were used. The animals were exposed to roentgen radiation in the following doses: 300 r, 400 r, and 500 r (250 kv, 10 ma, 4-mm. Al + 0.5-Cu, F.T.D. 40 cm.). The dose rate was 116 r/min. After irradiation the mice were exposed to explosive blasts in a special detonation chamber as described previously (Acta radiol. **43**: 101, 1955. Abst. in Radiology **65**: 968, 1955). One-third of the animals were exposed to the blast on the day of irradiation, another third were exposed seven days afterward, and the final third were subjected to blast injury fourteen days after irradiation.

Combining blast and radiation injuries did not significantly increase the mortality in mice, in comparison with animals receiving these injuries separately. Neither did an increase in blast pressure augment mortality from the combined injuries. This was true even when the blast was applied seven and fourteen days after irradiation, *i.e.*, during the period of expected lower resistance to infection and tendency to hemorrhage.

Three diagrams; 1 table.